# The MINING CONGRESS JOURNAL

*Volume* 13 JUNE, 1927 *No.* 6

**CONVENTION PROCEEDINGS ISSUE**

Fourth Annual Meeting, Practical Coal Operating Men

Full Proceedings of the Sessions on:
Coal Preparation
Mechanical Mining

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Display of Coal Mine Equipment

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Methods of Mine Sampling
Auriferous Placer Resources of California

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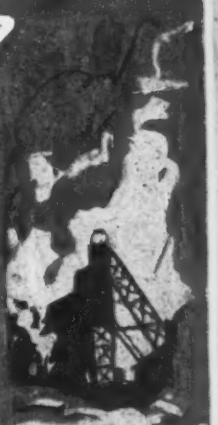
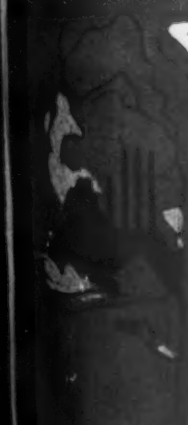
Grouting Methods Employed in Sinking the Harwick Coal & Coke Company Shaft



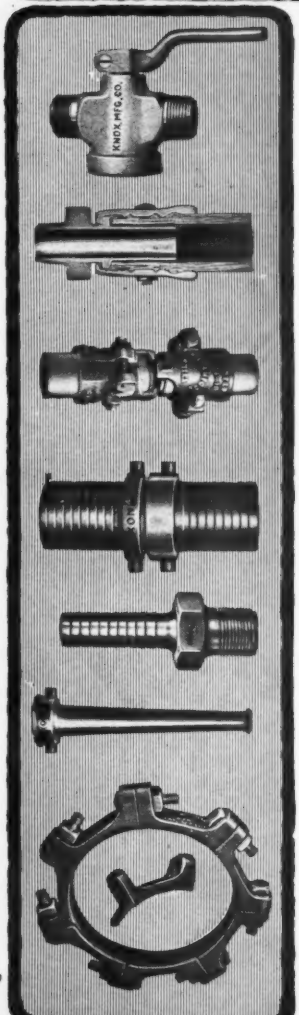


# KNOX

**Valves-Couplings-Nipples-Clamps-Menders**

## MINING SPECIALTIES

## The World's Standard

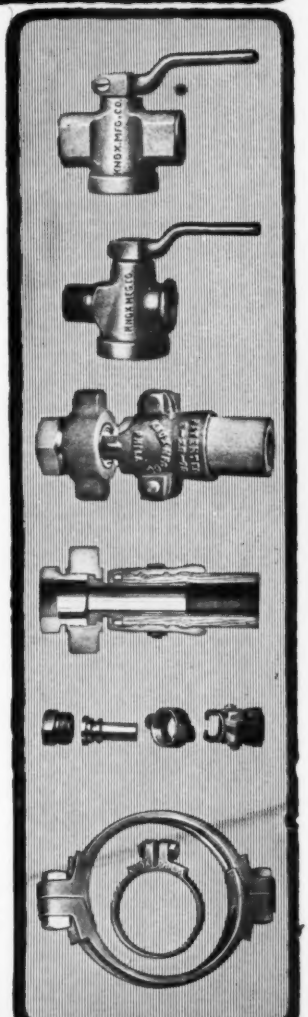


Knox Valves and Couplings —those "Silent Sentinels" on your air and steam lines, are being drafted into an army covering practically every mining camp in existence.

The allegiance they bear to those engaging their services is typical of their oath of enlistment. "We promise to suppress the escape of steam or air, Silently."

And before they are assigned to a unit occupying the front line trenches, G. H. Q. tests their ability to maintain this promise.

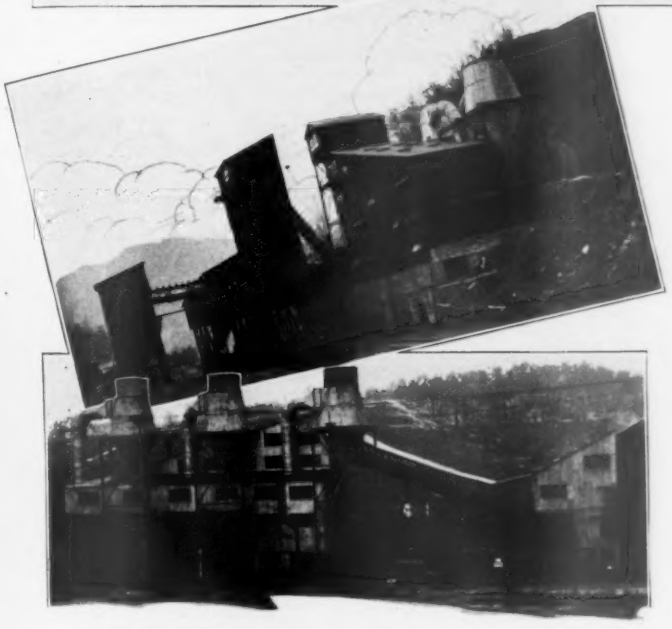
Any requisitions for additional "troops" should be sent to the training area below.



**KNOX MANUFACTURING CO.**

INCORPORATED 1911

817 Cherry St. Philadelphia, Pa.



Pittsburgh Coal Company
Library, Pennsylvania
Capacity, dry cleaner, 325 tons per hour

Algoma Coal & Coke Company
Algoma, West Virginia
Capacity, dry cleaner, 200 tons per hour

Berwind-White Coal Mining Company
Windber, Pennsylvania
Capacity, dry cleaner, 400 tons per hour

# DRY CLEANED COAL

*[air process]*

**Were you at Cincinnati? Did you hear the papers describing the success of these plants?**

Some of the discussions will appear in print—watch for them. These plants are equipped with Arms Screens and Concentrating Tables and the quality of the work they are doing is exciting considerable comment.

It is a subject upon which every bituminous operator should be posted and we will be glad to send you copies of these papers upon request.

## ROBERTS AND SCHAEFER CO.

ENGINEERS AND CONTRACTORS
CHICAGO, U. S. A.

418 Oliver Building
Pittsburgh, Pennsylvania

514 Ninth Avenue, Box 570
Huntington, West Virginia

Complete Mining Plants, Marcus Picking Table Screens, Arms Dry Cleaning Equipment, Rotary Car Dumpers, Car Handling Equipment, R and S Boom Loaders.

# THE MINING CONGRESS JOURNAL

JUNE, 1927 CONTENTS $3.00 Per Year 30c Per Copy

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**PRACTICAL OPERATING MEN'S DEPARTMENT**

METALS

*Methods of Mine Sampling*
*Auriferous Placer Resources of California*

COAL

*Grouting Methods Employed in Sinking the Harwick Coal & Coke Company Shaft*

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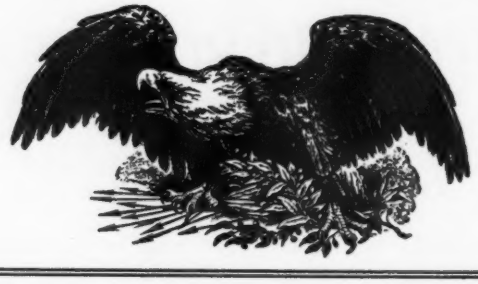

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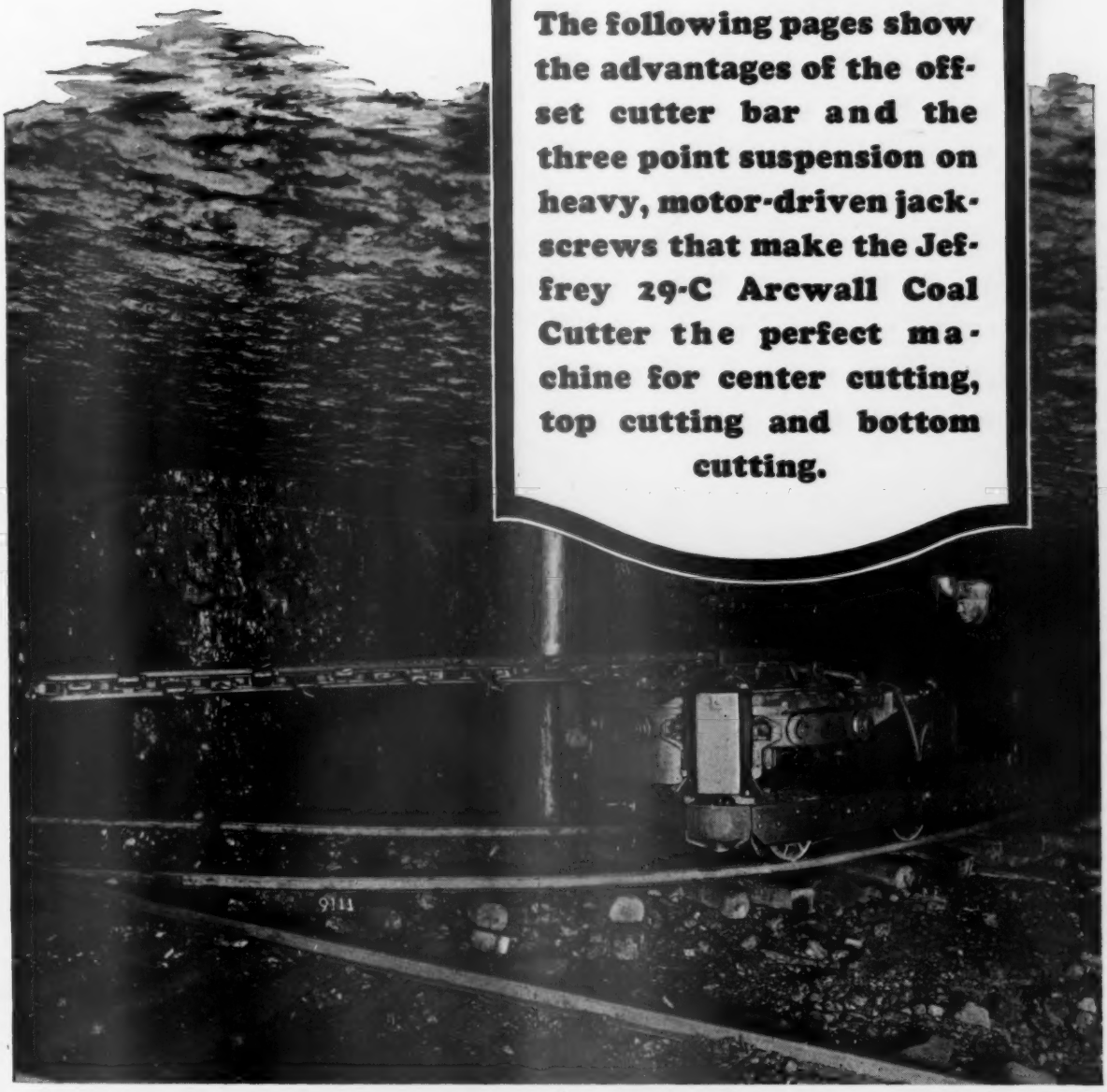
# Through Modern Mines with Jeffrey Arcwalls



**The following pages show the advantages of the offset cutter bar and the three point suspension on heavy, motor-driven jackscrews that make the Jeffrey 29-C Arcwall Coal Cutter the perfect machine for center cutting, top cutting and bottom cutting.**

50 YEARS OF SERVICE TO INDUSTRY

JEFFREY

COAL MINE EQUIPMENT

Jeffrey-Standard Coal Mine Equipment

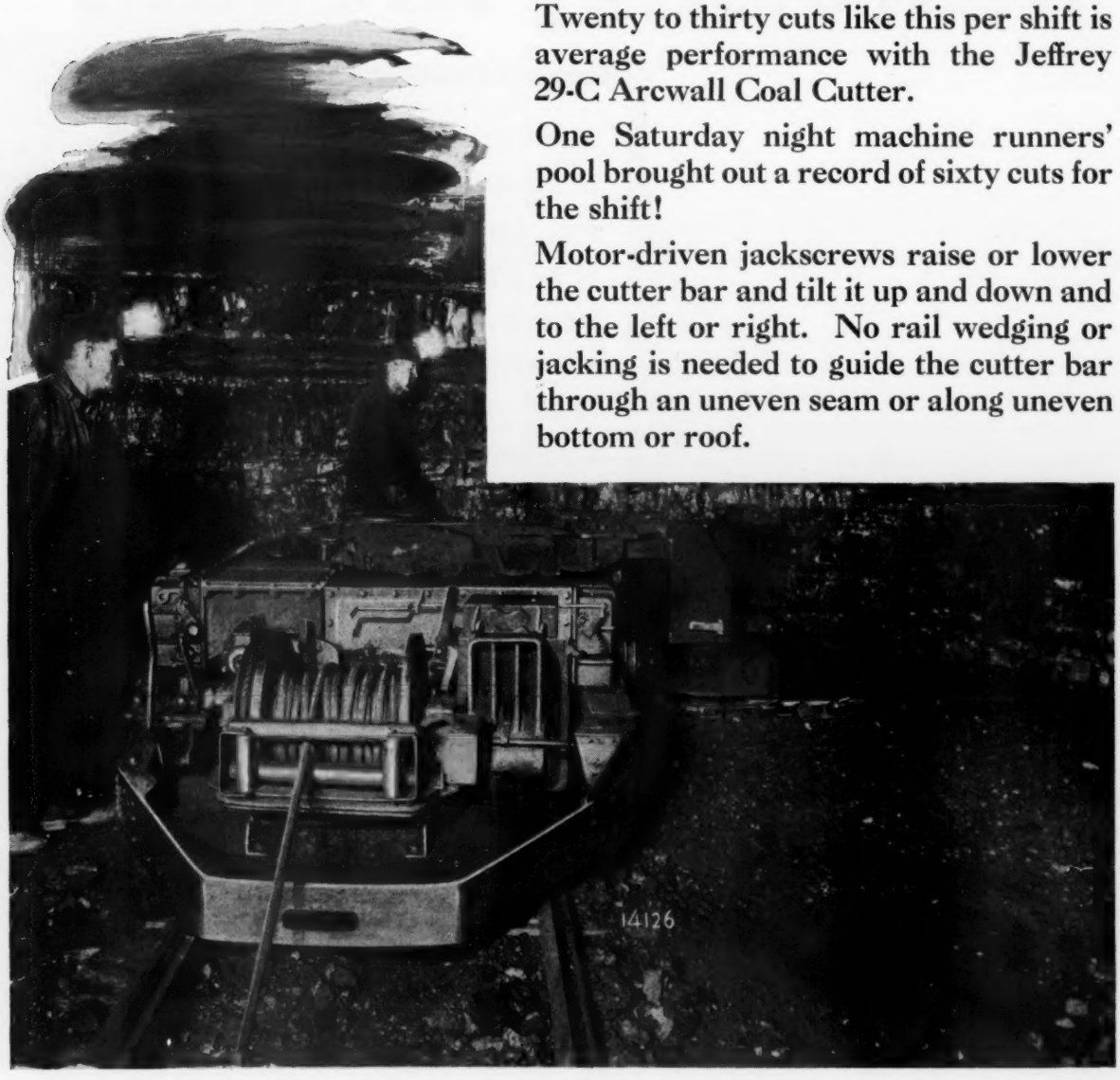
Coal Cutters
Combination Cutter and Loader
Drills
Conveyor-Loader
Sectional Conveyor
Pit Car Loaders
Locomotives
Mine Fans
Tipple Equipment
Crushers

# Cuts Twenty-Five

Twenty to thirty cuts like this per shift is average performance with the Jeffrey 29-C Arcwall Coal Cutter.

One Saturday night machine runners' pool brought out a record of sixty cuts for the shift!

Motor-driven jackscrews raise or lower the cutter bar and tilt it up and down and to the left or right. No rail wedging or jacking is needed to guide the cutter bar through an uneven seam or along uneven bottom or roof.




The Jeffrey Manufacturing Company

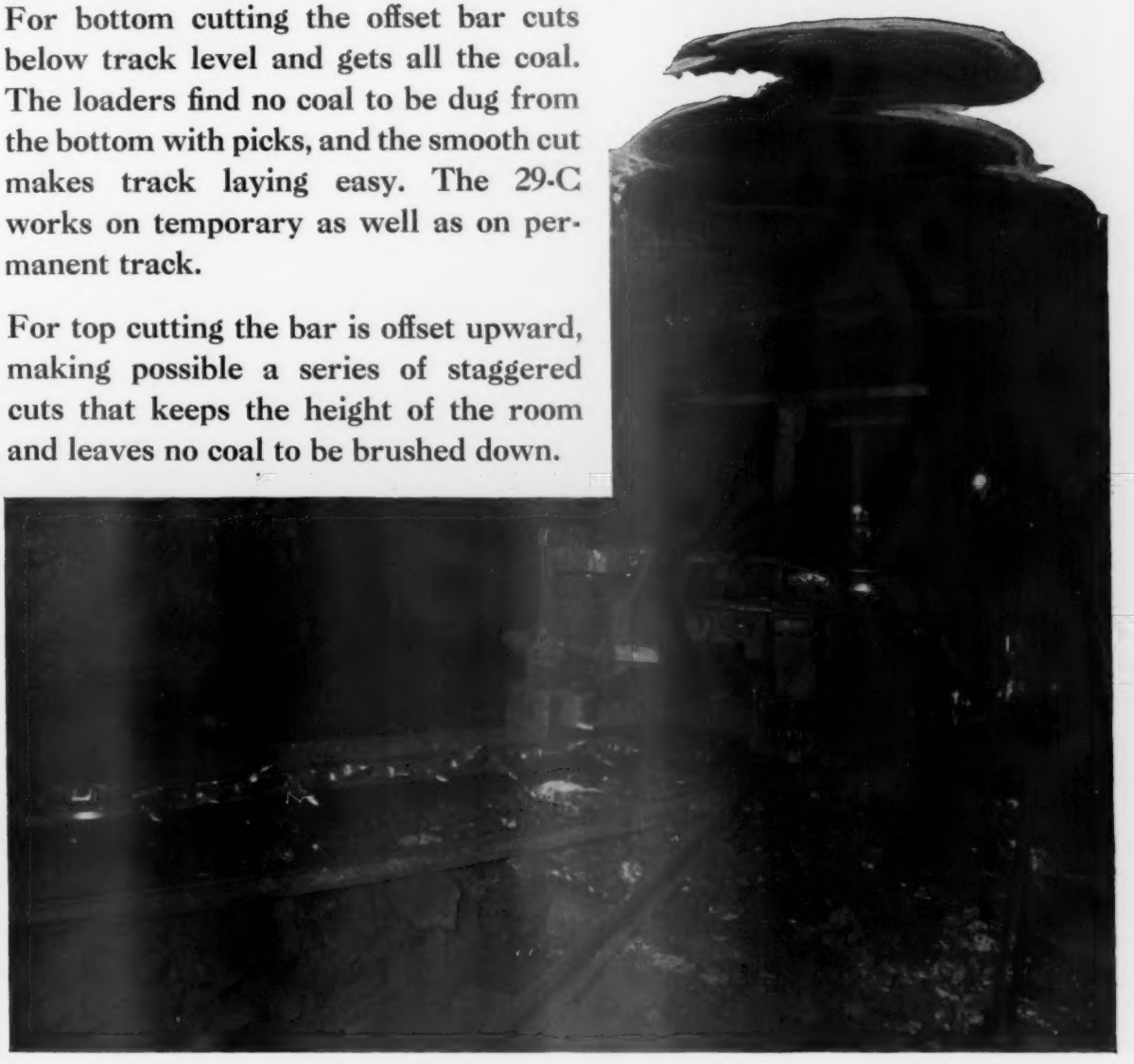
New York
Philadelphia
Scranton, Pa.
Pittsburgh
Chicago
Charleston, W. Va.
Salt Lake City
Denver
Birmingham
Montreal, Canada

JEFFREY

# Places Per Shift

For bottom cutting the offset bar cuts below track level and gets all the coal. The loaders find no coal to be dug from the bottom with picks, and the smooth cut makes track laying easy. The 29-C works on temporary as well as on permanent track.

For top cutting the bar is offset upward, making possible a series of staggered cuts that keeps the height of the room and leaves no coal to be brushed down.



958-99 North Fourth St., Columbus, Ohio

Sales and Service Stations

Salt Lake City, 153 W. 2d South St.
Winchester, Ky., 122 N. Main St.
Pittsburgh, 600 2d Ave.
Birmingham, 26 S. 20th St.
Terre Haute, Ind., 319 Cherry St.
Scranton, 122 Adams Ave.

# Coal Mine EQUIPMENT

# Drawing Ribs With an Arcwall

In thick, solid coal where there is no parting many operators use the 29-C Arcwall for slabbing. They find that two light shots, one above and one below the cut, produce more lump than the single heavy shot burning an equal amount of powder.

The three-point flexible suspension on heavy, motor-driven jackscrews changes the direction of the cutter bar to follow both the irregularities in the seam and the uneveness of the track.

The two forward screws tilt the cutter bar sideways and the rear screw raises or lowers the nose.

This flexible, three-point-suspension on motor-driven jackscrews on the 29-C Arcwall is an exclusive Jeffrey feature.

*For gaseous mines Jeffrey builds Government Approved Permissible Arcwalls*

The Jeffrey Mfg. Co., 958-99 North Fourth St., Columbus, Ohio

New York Philadelphia Scranton, Pa. Pittsburgh Chicago Charleston, W. Va. Salt Lake City Denver Montreal, Canada Birmingham

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50 YEARS OF SERVICE TO INDUSTRY

# JEFFREY
## COAL MINE EQUIPMENT

Jeffrey-Standard Coal Mine Equipment
Coal Cutters
Combination Cutter and Loader
Drills
Conveyor-Loader
Sectional Conveyor
Pit Car Loaders
Locomotives
Mine Fans
Tipple Equipment
Crushers

# The Myers-Whaley Shovel

## *The All-Around Loader for Underground Work*

**We appreciate the attention shown our machine on exhibit at Cincinnati May 16th-20th, and thank our many friends for their kind remarks.**

**MYERS-WHALEY SHOVELS have been in great demand this past year, and are being shipped as fast as built, but a Mining Congress Exhibit would not be complete without a "MYERS-WHALEY" (at least that's what our friends say) so we exhibited one of our No. 4 Size Approved Permissible Shovels—The last word.**

**There has been great progress made in the use of MYERS-WHALEY SHOVELS this past year, in all departments of mechanical loading underground. Over 500 tons of coal per day with one machine (two shifts) is averaged by one mine. Another is loading coal on one shift, rock on the other. Others are doing great work in Heading Driving, Brushing, Grading, etc. And MYERS-WHALEY SHOVELS have broken the World's Record for Rapid Tunnel Driving in Rock—three times in three successive months—1,157 feet of 8 ft. by 9 ft. tunnel in one heading through granite on the Cascade Tunnel in 31 days.**

**Our representatives, familiar with the operation of MYERS-WHALEY SHOVELS under many different conditions, will be glad to discuss your conditions with you.**

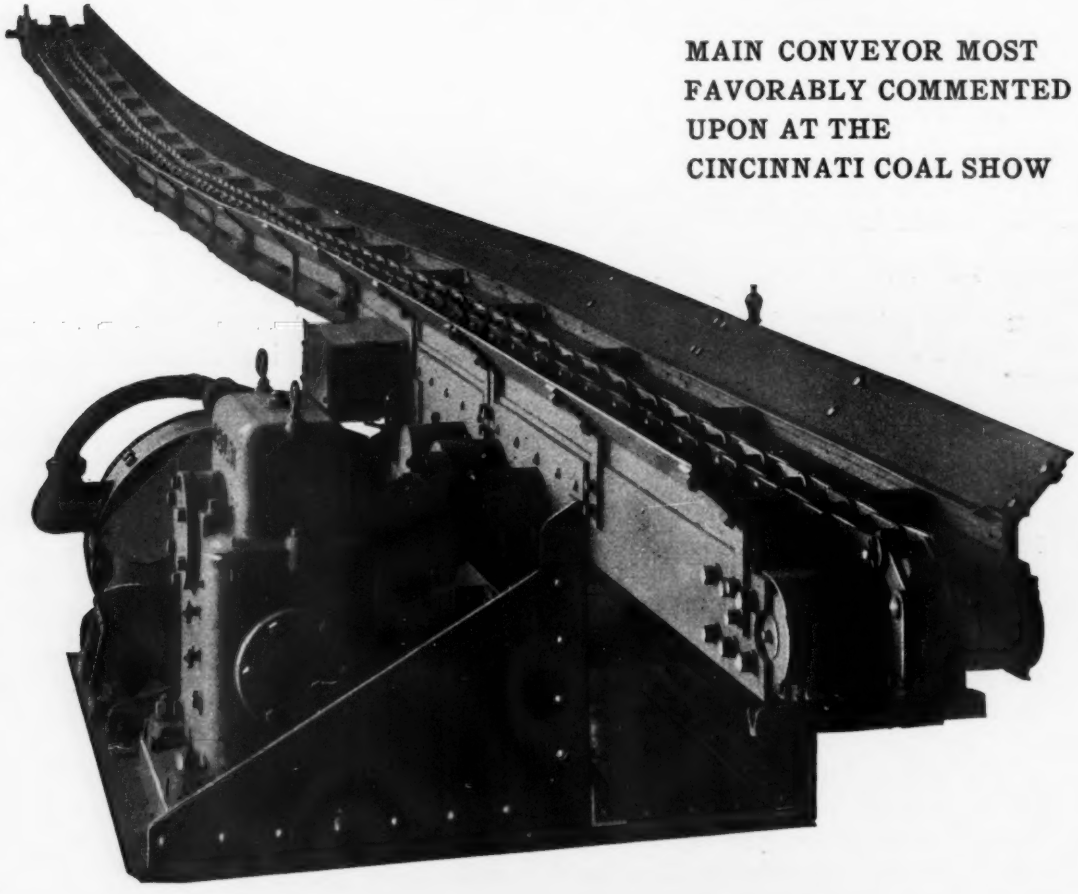
***Catalog on Request***

**MYERS-WHALEY COMPANY**
**KNOXVILLE, TENNESSEE**

***"The Pioneer Manufacturers of Coal Loading Machines."***

# Tracy's Koalveyor

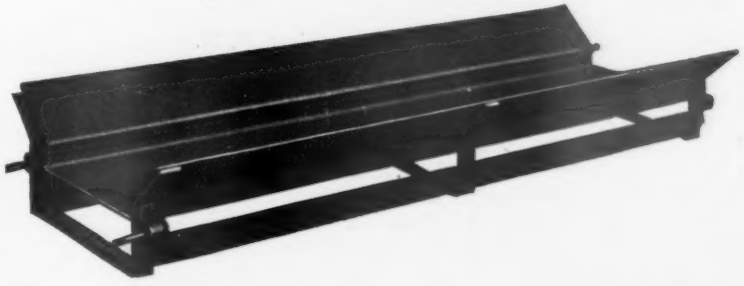
MAIN CONVEYOR MOST
FAVORABLY COMMENTED
UPON AT THE
CINCINNATI COAL SHOW



FACE CONVEYOR
DRIVEN FROM TAIL END OF
MAIN CONVEYOR

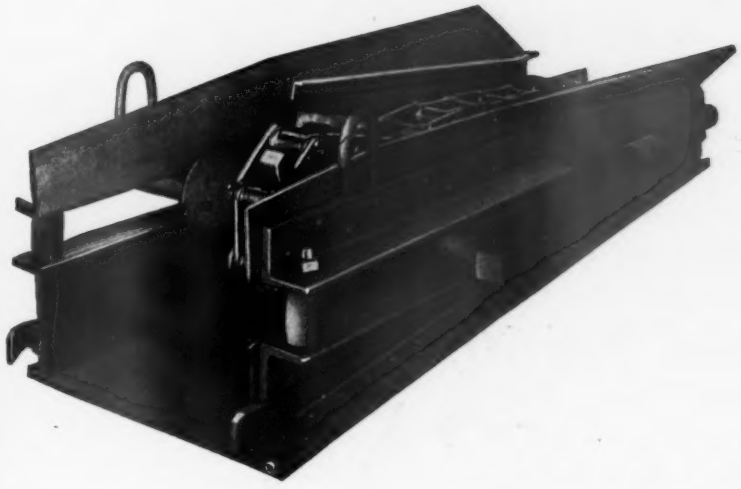
## Bertrand P. Tracy Co.,

# Tracy's Koalveyor



PAN SECTION
STANDARD LENGTH 6 Ft.

INTERMEDIATE DRIVING SECTION, INTERCHANGEABLE WITH PAN SECTIONS, FOR LOCATING LATERAL CONVEYORS AT ANY POINT ON MAIN CONVEYOR



TAIL END SECTION SHOWING SHAFT EXTENSION FOR DRIVING FACE CONVEYOR

**INQUIRIES SOLICITED**
**OUR ENGINEERS ARE AT YOUR SERVICE**

**Pittsburgh, Pa.**

# Pneumatic Coal Separation Record

## 1920-1925

*Annual separating capacity installed* 1,776,000 *tons*

ST. LOUIS, ROCKY MOUNTAIN & PACIFIC COAL CO., Brilliant, N. M.
McALLESTER-EDWARDS COAL COMPANY, Pittsburgh, Okla.
AMERICAN COAL CO., OF ALLEGHENY COUNTY, McComas, W. Va.
GULF SMOKELESS COAL COMPANY, Wyco, W. Va.
WEST CANADIAN COLLIERIES, Limited, Blairmore, Alberta, Canada.
NATIONAL CARBON COMPANY, Niagara Falls, N. Y.
SEMET SOLVAY COKE COMPANY, Detroit, Mich.
PREMIER RED ASH COAL CORPORATION, Red Ash, Va.
HEWORTH COAL COMPANY, Limited, Heworth, County Durham, England.

## 1926

*Annual separating capacity installed* 2,784,000 *tons*

INTERNATIONAL COAL & COKE CO., Limited, Coleman, Alberta, Canada.
McGILLIVRAY CREEK COAL & COKE CO., Coleman, Alberta, Canada.
JOHN BOWES & PARTNERS, Limited, Wardley, County Durham, England.
*AMERICAN COAL CO., OF ALLEGHENY COUNTY, McComas, W. Va.
TURKEY GAP COAL & COKE COMPANY, Modoc Colliery, Wenona, W. Va.
McALPIN COAL & COKE COMPANY, McAlpin, W. Va.
SUPERIOR POCAHONTAS COAL COMPANY, Davy, W. Va.
NEW RIVER & POCAHONTAS CONSOLIDATED COAL CO., Berwind, W. Va.
ALTHAM COLLIERIES, Limited, Accrington, Lancashire, England.
*PREMIER RED ASH COAL CORPORATION, Red Ash, Va.

## *So far 1927*

*Annual separating capacity sold* 3,100,800 *tons*

PEASE & PARTNERS, Ltd., Thorne Colliery, Near Doncaster, Yorkshire, Eng.
HORDEN COLLIERIES, Limited, Horden Colliery, County Durham, Eng.
*WEST CANADIAN COLLIERIES, Limited, Bellevue, Alberta, Canada.
HEBBURN COLLIERIES, Limited, Newcastle, Australia.
*NEW RIVER & POCAHONTAS CONSOLIDATED COAL CO., Berwind, W. Va.
PEARSON AND DORMAN LONG, Ltd., Snowdown Colliery, Kent, England.
*PREMIER RED ASH COAL CORPORATION, Red Ash, Va.

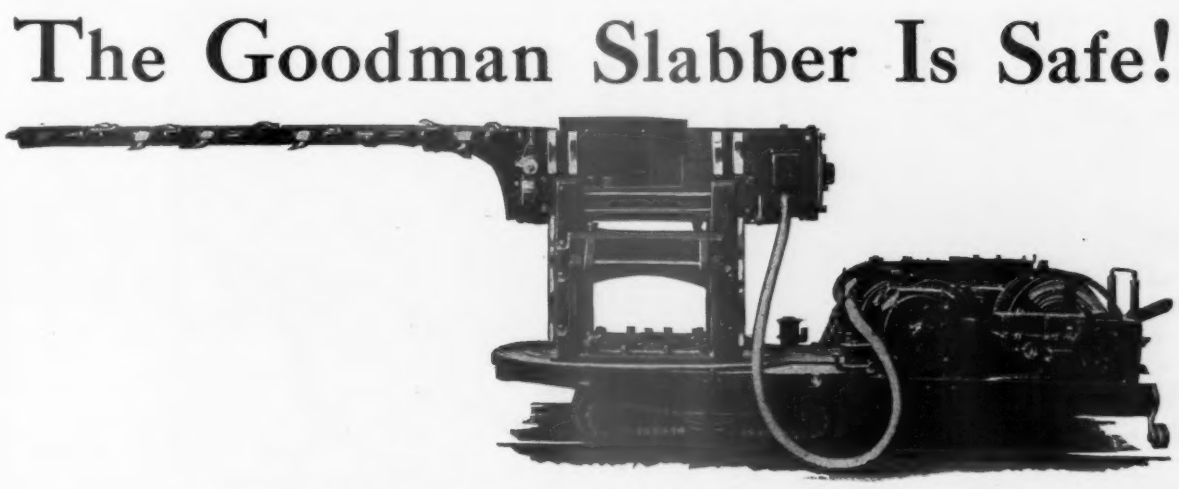
*Repeat orders.

## *Total 7,660,800 tons*

AMERICAN

COAL CLEANING CORPORATION
Welch, W. Va.

# The Goodman Slabber Is Safe!



A Goodman Permissible (Government Approved) Slabber with Folding Side Frames; Cutting Element raised for high or top cutting.

## Consider Your Runners—

### In Your Selection of an Overcutting Machine

The *"Safety First"* Design of the Goodman Slabbing Machine

### PROTECTS YOUR MACHINE MEN!

**And Here's How:**

The Cutter Arm is Swung by *Spur and Worm Gearing,* which *automatically locks* the Cutter Arm in any position at which the Motor is stopped.

Thus the Machine Men are protected against injury from unexpected "kick backs" of a free Cutter Arm—the turntable being

**Positively Geared and Automatically Locked.**

***A Significant Goodman SAFETY Feature!***

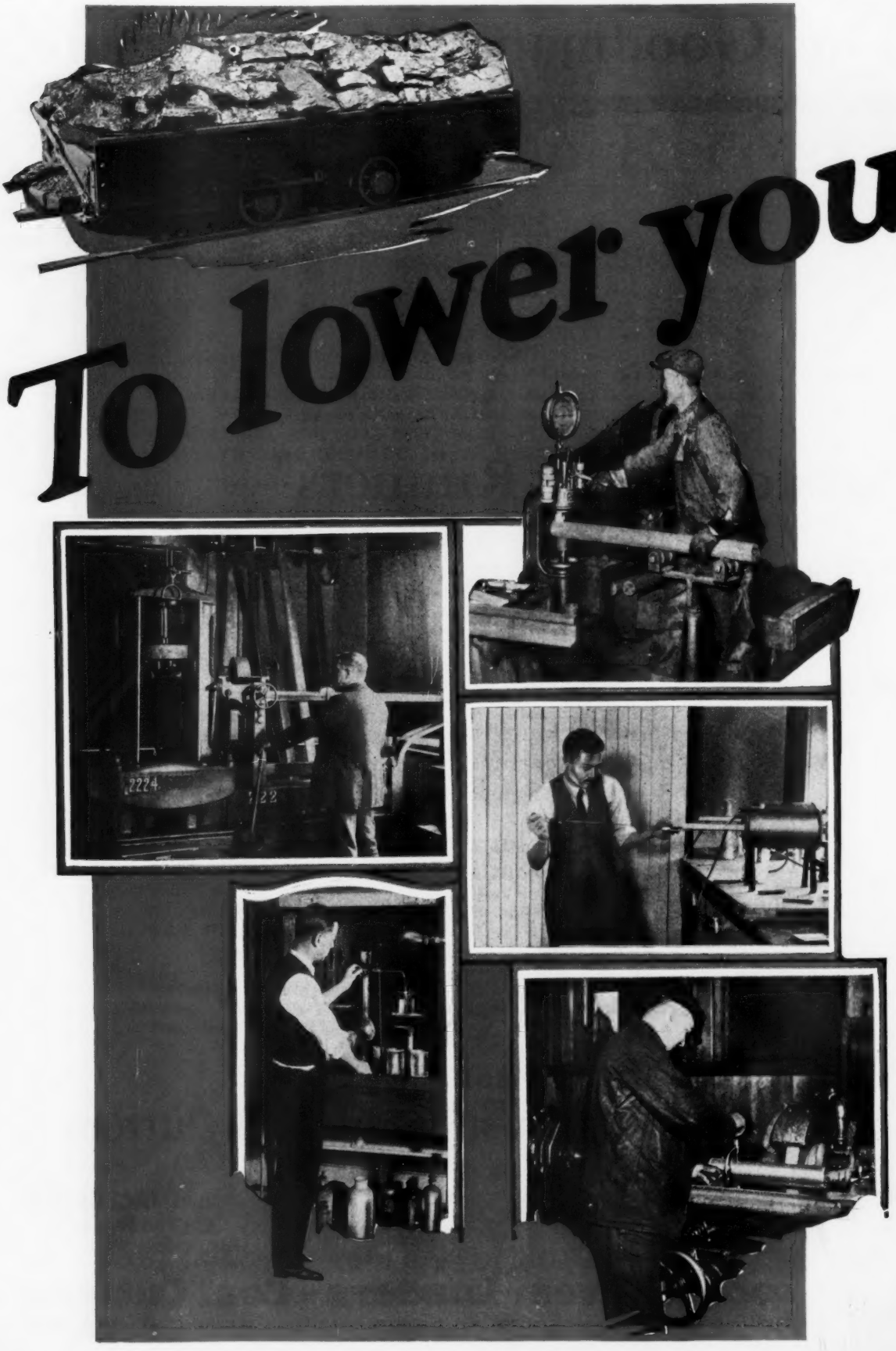
## Conscientious Consideration Confirms SAFE Coal Cutters

(57)

**GOODMAN** MANUFACTURING COMPANY
HALSTED ST. at 48TH
CHICAGO - - - ILL.

**Locomotives - Loaders - Coal Cutters**

PITTSBURGH – CHARLESTON, W.VA. – HUNTINGTON, W.VA. – CINCINNATI – BIRMINGHAM – ST. LOUIS – DENVER – PRICE, UTAH


To lower your

# cost per ton—

## —your cars must pass these pre-service tests

### Chemically OK'd

When you see heavily loaded cars—a long string of them—pounding over the tracks, does it occur to you that their service capacity can be largely determined in advance by chemical as well as mechanical tests? Chemical tests prove conclusively whether various car parts are going to withstand shocks, strains and wear.

The pig iron and other ingredients used for making "Car Foundry" Wheels are tested. A. F. Iron for couplings and drawbars is similarly tested by chemistry. The steel from which "Car Foundry" Steel Axles are made is tested. Steel sides, ends and bottoms are also OK'd chemically. Even the coal used in the "Car Foundry" furnaces is tested.

### Mechanically OK'd

Mechanical tests as well as inspections by experts follow through after each step in the manufacture of "Car Foundry" Cars.

The A. F. Iron for drawbars is tested for pulling capacity. The special axle steel is tested for carrying capacity. The metal of the wheels is inspected before and after the wheels are formed. And many inspections of workmanship and checks on accuracy required are made while the various parts are being machined.

**"CAR FOUNDRY"**
**Vs.**
**"HOME-MADE CARS"**

You specialize in producing coal. Building cars is just as specialized an art. You cannot expect to build as high quality, as suitable, as durable cars as "Car Foundry" Specialists. Nine times out of ten, not only will the ultimate cost of "Car Foundry" Cars be less but the initial cost as well.

Buy "Car Foundry" Cars

### Better Made Cars Not Made

In fact nothing is left undone which can be done by scientific procedure and up-to-date facilities to make certain that "Car Foundry" Cars and car parts are going to withstand the toughest service to which cars are subjected in the mine.

### Cars and Co-ordination

Only with Cars made and tested the "Car Foundry" way can you be assured of maximum car service, minimum car maintenance expense, continuous coal transportation, the highest production and lowest possible cost of operation of your entire system.

### Vital to Continuous Operation of ALL Your Equipment

Without maximum car service, your hoists, undercutters, mechanical loaders, drills, and coal preparation equipment cannot work to full capacity.

### Pay for Themselves

"Car Foundry" Cars pay for themselves by making possible more continuous operation of all your equipment through a more constant flow of coal, by lower car maintenance cost—by lower costs per ton from face to railroad cars.

### Write the nearest branch

Write for particulars on how "Car Foundry" Cars are lowering the cost per ton of leading mines throughout the coal regions.

**American Car and Foundry Company**

New York, Berwick, Pa. — St. Louis, Bloomsburg, Pa. — Chicago, Huntington, W. Va. — Pittsburgh, Terre Haute, Ind.

acf "CAR FOUNDRY"

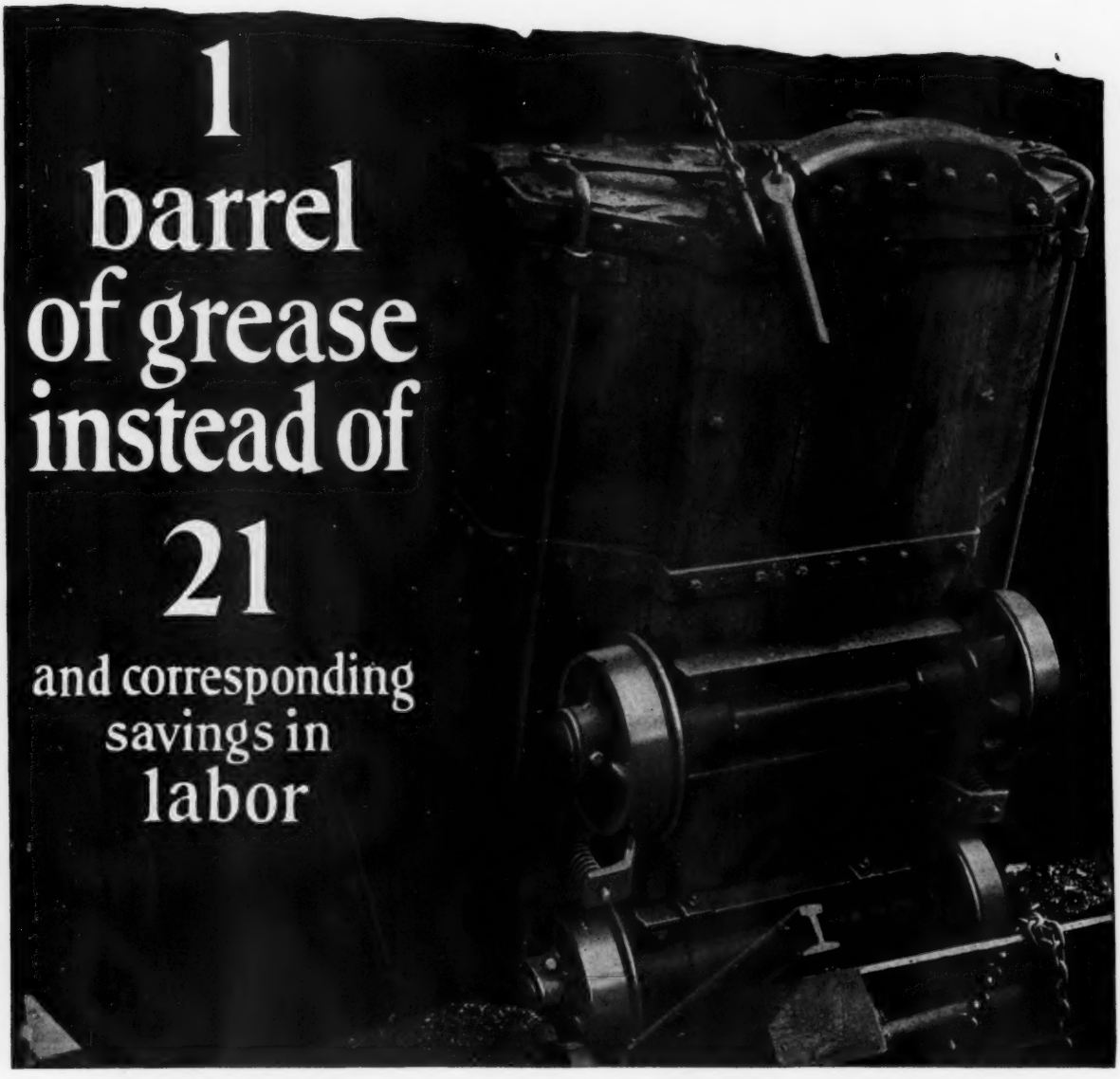
ELECTRIC RIVET HEATERS
BARS, IRON and STEEL
CAR IRONS

BOLTS, NUTS, RIVETS
IRON BODY GATE VALVES
CAR TRUCKS

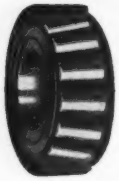
CHILLED IRON WHEELS
PINS AND LINKS
FLANGED PIPE

# 1 barrel of grease instead of 21

and corresponding savings in labor



*Timken-equipped cars for Hughes No. 14 were built by American Car and Foundry Co.*



"THE entire amount of grease used by us since receiving the Timken-equipped cars will be a little less than one barrel. On plain bearing wheels on an equal number of cars (100) we would have used one barrel per month for the same twenty-one month period."

Here is better than a 95% grease saving reported by Mr. R. H. Moore of W. H. Hughes & Co., operators of Hughes No. 14 at Twin Rocks, Pa. Each greasing lasts for five or six months, saving hundreds in labor cost! And the cars are "far superior in every respect," states Mr. I. P. Bradley, of the same company. They shoulder most easily and save power, since Timken Tapered Roller Bearings conquer friction. They stay out of the shop, because there is full protection against thrust, shock, and radial load, in Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken electric steel.

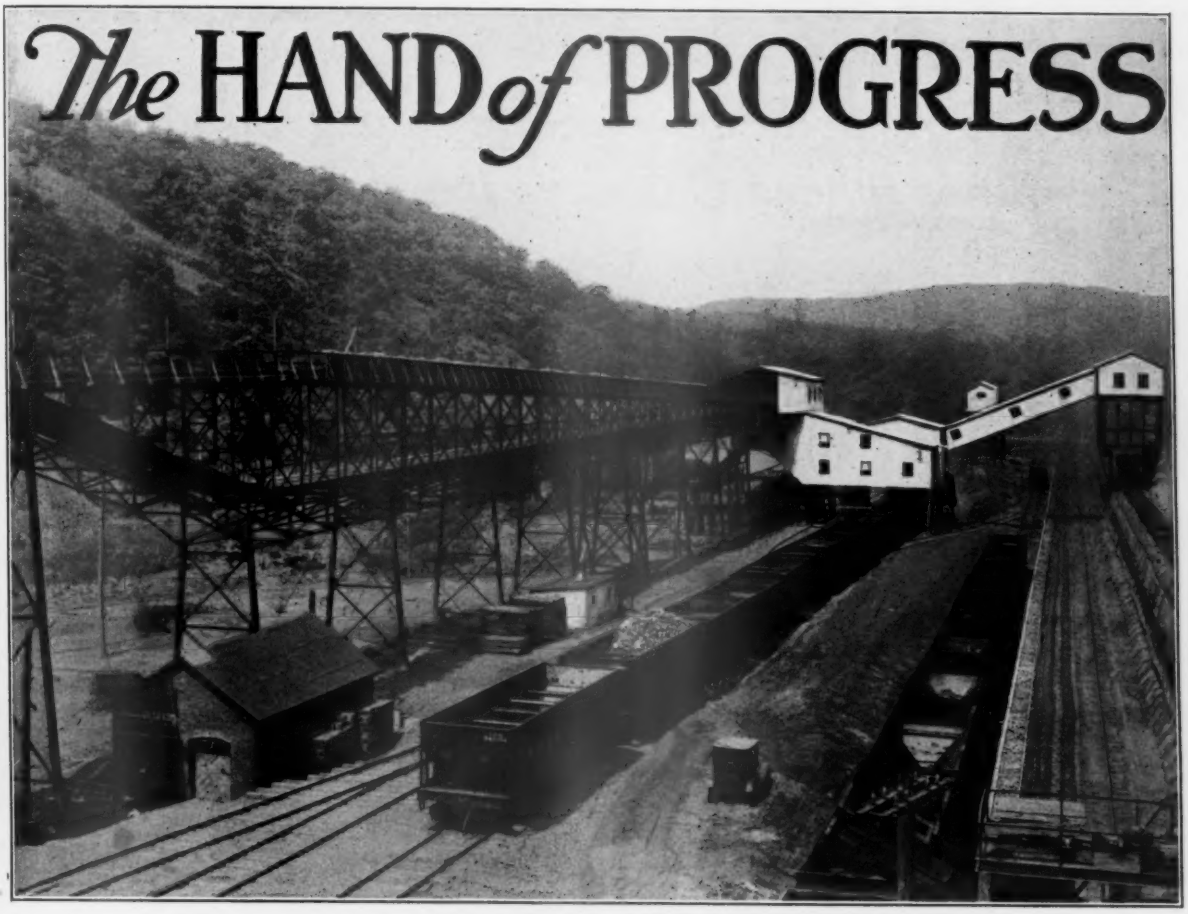
So, like innumerable well-informed operators, Hughes announce that "for some time we have adopted the practice of replacing all worn-out trucks with Timken equipment."

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

**TIMKEN** *Tapered Roller* **BEARINGS**

COAL MINE TRADE MARK REGISTERED FAIRMONT EQUIPMENT

# *The* HAND *of* PROGRESS



Progress is the keynote of America's success. The Coal Industry, like other industries, is progressing.

The Snowdon Coke Company, near Brownsville, Pa., replaced last year, their old tipple with this modern steel tipple.

Fairmont Engineers, Fairmont Shops, and Fairmont Erection crews did the job.

*If you are interested in air cleaning, consult us*
*We are at your service—no obligation*

**FAIRMONT MINING MACHINERY COMPANY**
**FAIRMONT, W. VA.**

FAIRMONT ENGINEERING PRACTICE IS BACKED BY A QUARTER CENTURY OF EXPERIENCE

# COLODER Production Records

## *These records were made in a group of 8 mines where Coloders were first used*

| | 1924 | 1925 | 1926 |
|---|---|---|---|
| Number of Coloders | 22 | 22 | 22 |
| Total number of shifts | 5495 | 5944 | 6501 |
| Capacity of mine cars | 3.37 | 3.59 | 3.56 |
| Average tons per shift | 277 | 287 | 286 |
| Total net tons loaded | 1682000 | 1709000 | 1862000 |
| Cost per ton, repair parts | $.030 | $.031 | $.029 |
| Cost per ton, repair labor | $.005 | $.002 | $.002 |

# The COLODER

**A STEADY FLOW OF COAL**
**from the face to railroad car! The dream—the ideal of the mine manager.**

**Watch the flow of coal on a big belt conveyor: endless—continuous.**

**Watch the flow of coal as a big trip of modern pit cars speeds by on a real railroad.**

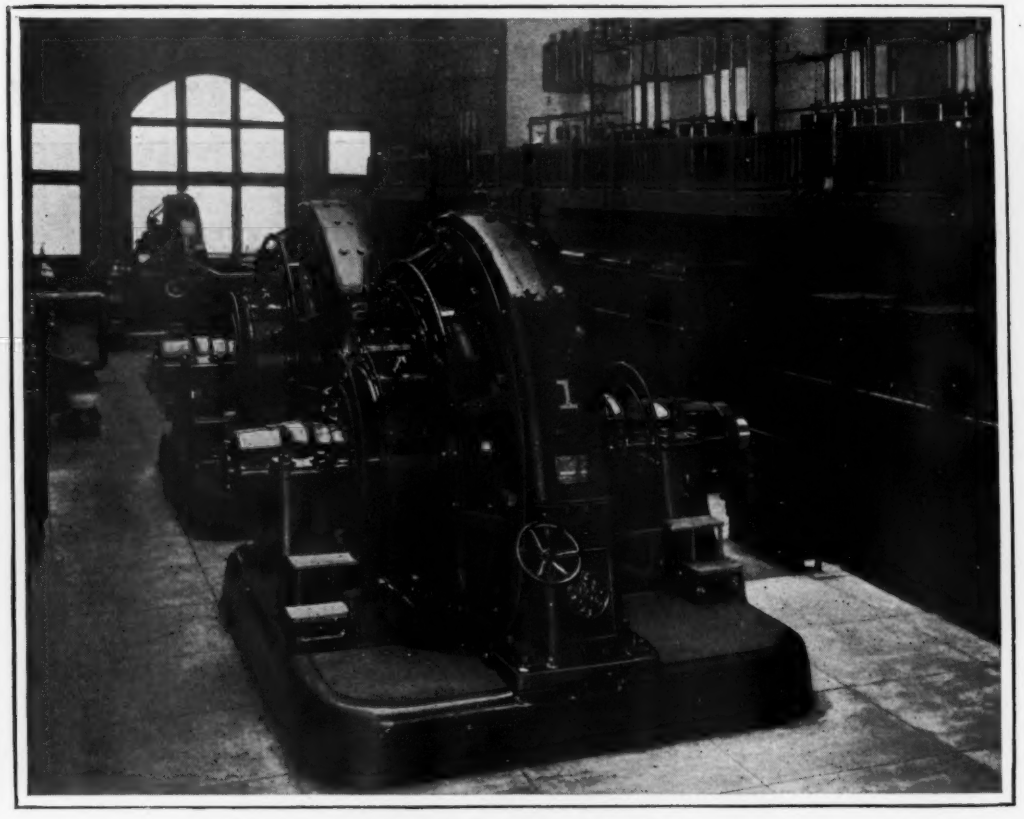
**Watch the rapid flow of coal from face to pit car through a Coloder: effortless—continuous—quiet.**

**A dream realized! An ideal attained!**

## The Coloder Company, Inc.

**568 North Fourth St.**

**COLUMBUS, OHIO**



*Irvington Substation, New York Central R. R.*

# The public rides on NCC Brushes

THOSE who go in and out of New York City on the Hudson River division of the New York Central travel in trains supplied with power from substations such as this one at Irvington, where National Pyramid Brushes are used. Here are three rotary converters of General Electric manufacture, which supply the track feeder system from which power is drawn not only by the electric short haul trains, but also by the electric locomotives that pull such trains as the 20th Century into Grand Central Terminal.

**National**
**Pyramid Brushes**

NATIONAL CARBON COMPANY, INC.

*Carbon Sales Division*

Cleveland, Ohio San Francisco, Cal.

*Unit of Union Carbide and Carbon Corporation*

*Emergency Service Plants*

CHICAGO, ILL.
551 West Monroe St.
*Phone:* State 6092

PITTSBURGH, PA.
7th Floor, Arrott Power Bldg., No. 3, Barker Place. *Phone:* Atlantic 3570

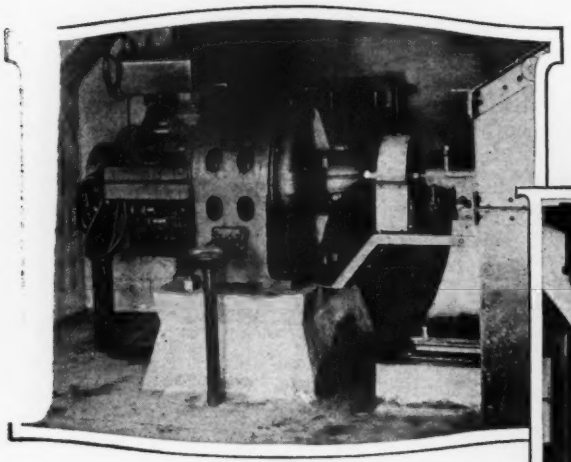
NEW YORK, N. Y.
357 West 36th St.
*Phone:* Lackawanna 8153

BIRMINGHAM, ALA.
1824 Ninth Ave. N.
*Phone:* 3—6091

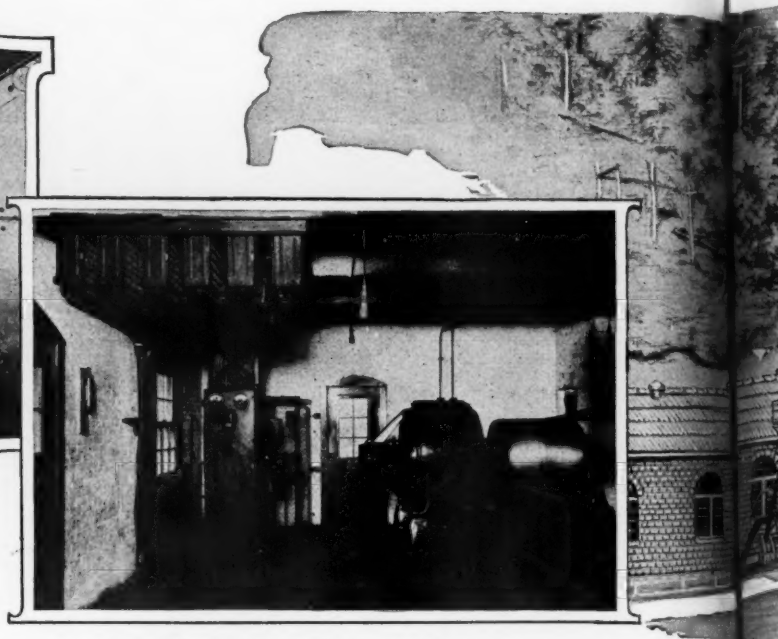
# Roebling

*A Name Renowned in Wire Rope Manufacture*

John A. Roebling's Sons Company
Trenton, New Jersey



*G-E brush-shifting, adjustable-speed, alternating-current motor driving fan. Arranged for automatic control from a remote point.*



*G-E 250 h.p. adjustable-speed, slip-ring induction motor connected by belt to fan at a Pennsylvania coal mine.*

# *Ventilation*-
## For the Breath of Life - and Safety

G-E engineers have given this phase of mining special attention in their development of constant and variable speed motors of many types for belt, chain, gear, and direct-coupling applications to fans. G-E motors are designed for unusually high operating efficiencies which insure economical operation in this almost continuous service. G-E automatic control secures the proper starting and stopping of motors from remote points, and provides protection to motors against single-phase operation and severe overloads.

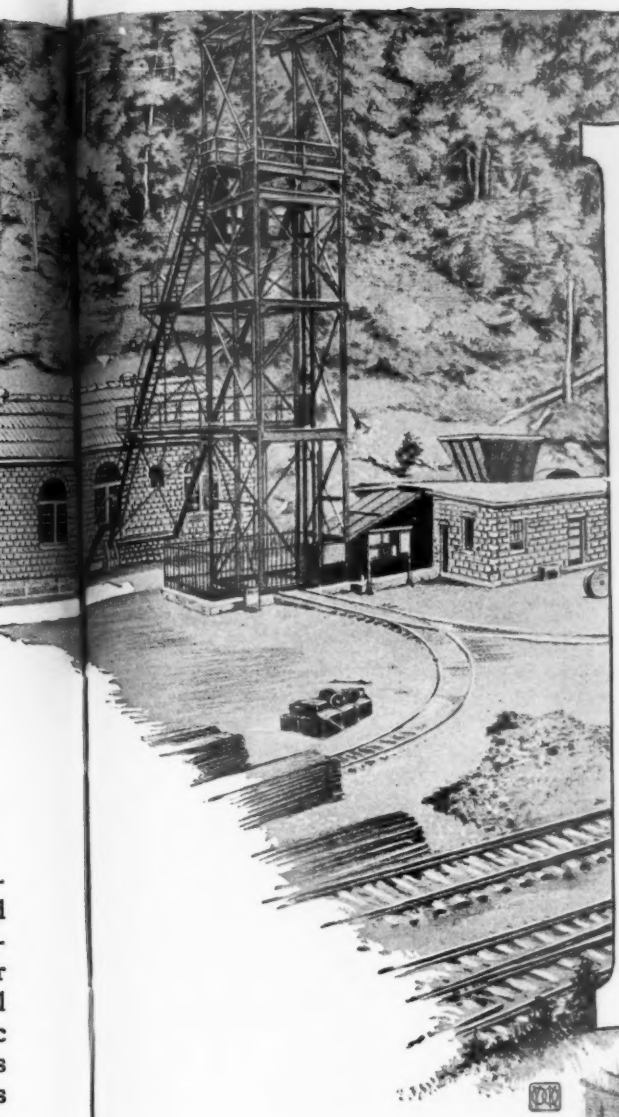
The increasing use of G-E Motorized Power for mine fan drive is based on records of dependable performance in this vital service. In electrifying your ventilation system you will find practical experience which provides satisfactory results at your nearest G-E office.

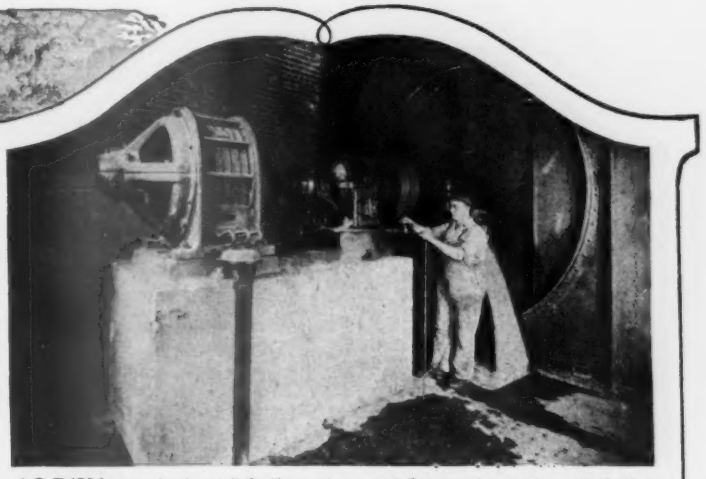
Apply the proper G-E motor and the correct G-E controller to a specific task, following the recommendations of G-E specialists in electric drive and you have G-E Motorized Power. "Built in" or otherwise connected to all types of industrial machines, G-E Motorized Power provides lasting assurance that you have purchased the best.

**Motorized Power**
*—fitted to every need*

# GENERAL

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.



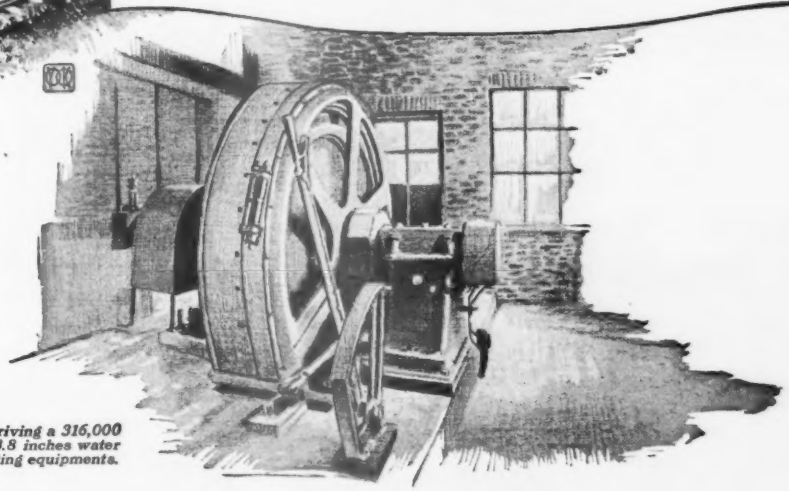


*A G-E 150 h.p. squirrel-cage induction motor, coupled to speed-reduction unit, driving fan at a Glen Alden mine.*

**VENTILATION is only one phase of coal mine operations served by General Electric. Thorough electrification and G-E equipment combine to obtain high unit production and low unit costs also in**

**Hauling—Hoisting—Pumping—Cutting and Shearing—Loading and Conveying—Rockdusting—Air Compressing—Preparation—Stripping—Power Generation—Power Distribution and Conversion—Etc.**

**Whatever the need, G-E meets it so dependably and economically that each General Electric installation recommends another.**



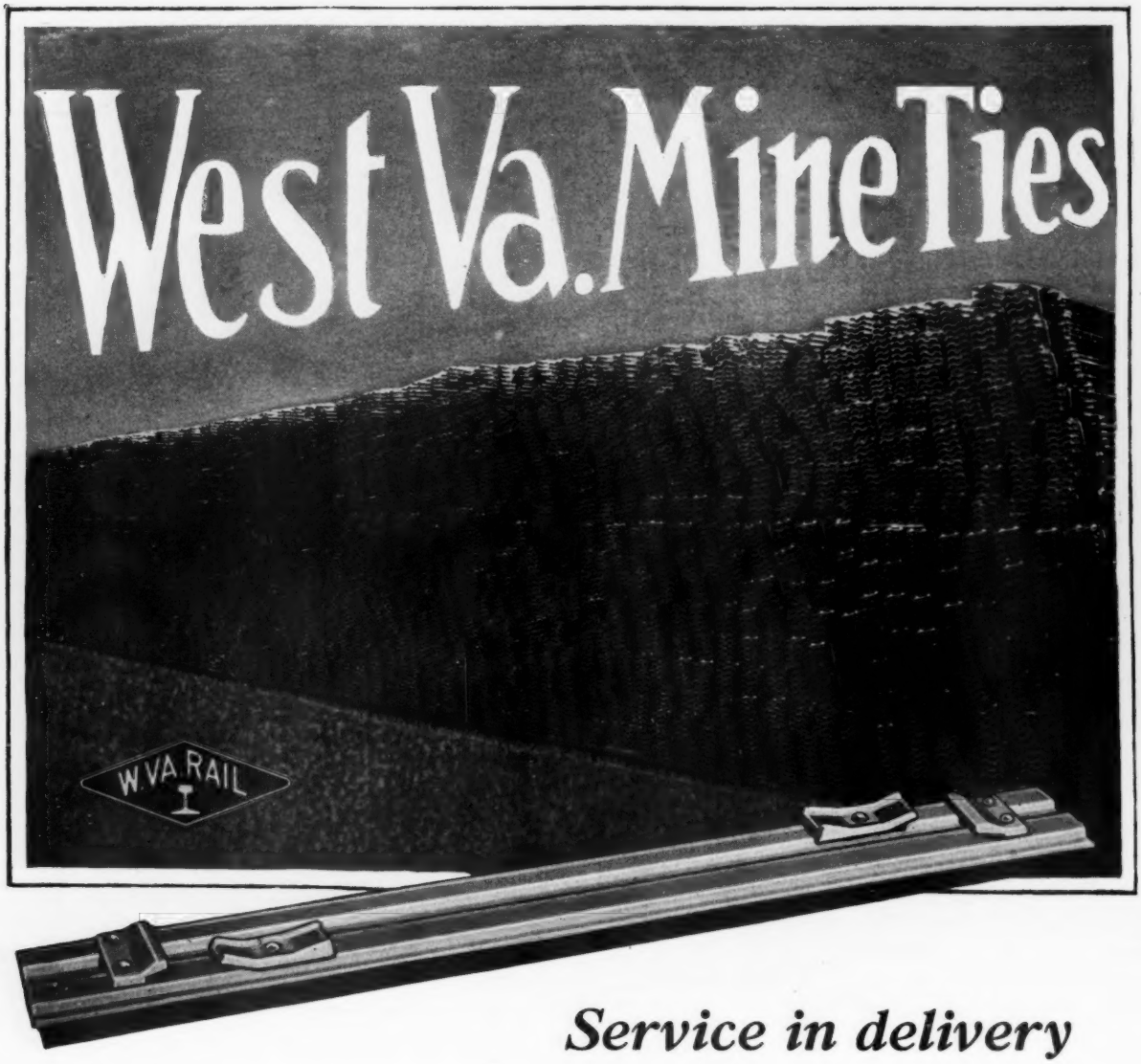
*G-E 400 h.p. Super-Synchronous motor driving a 316,000 cu. ft. per minute ventilating fan against 3.8 inches water gauge. A forward step in coal mine ventilating equipments.*

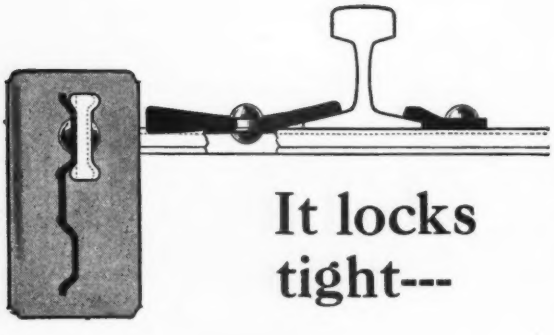
200-28

# ELECTRIC

SALES OFFICES IN PRINCIPAL CITIES

# West Va. Mine Ties



It locks tight---

W.VA.RAIL

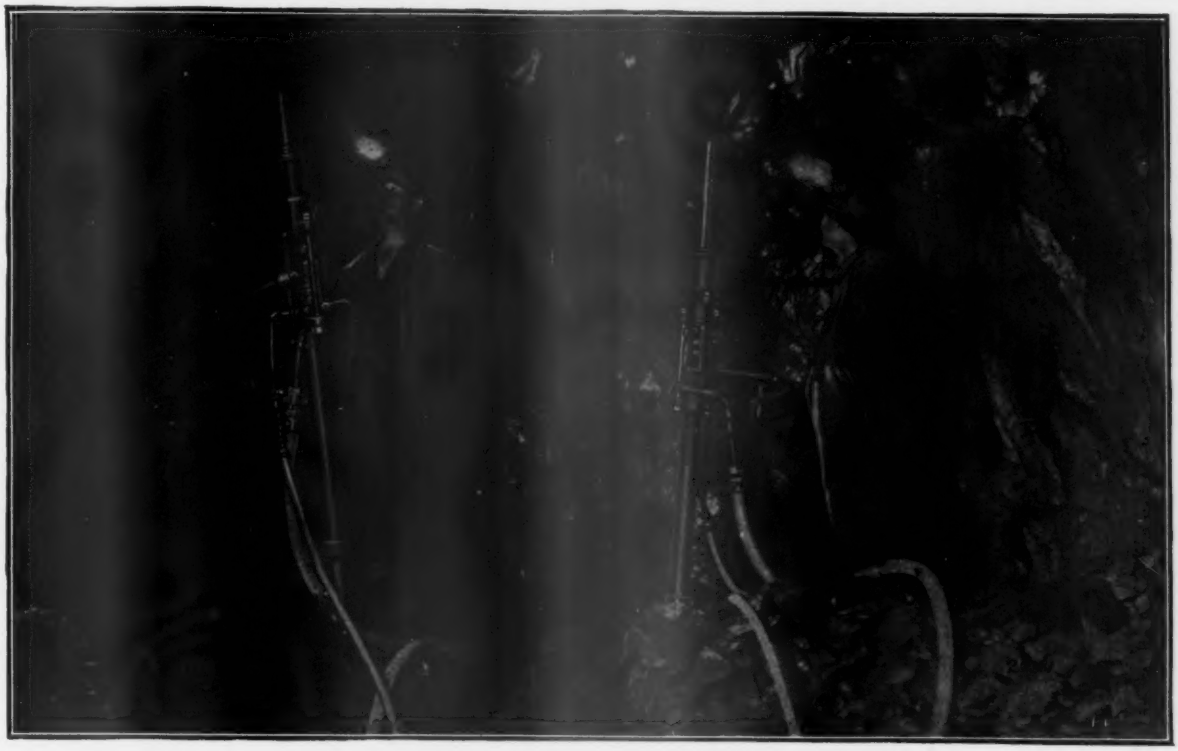
## *Service in delivery*
## *Service in use---*

Service in delivery that is made possible by immense stocks of standard ties and by large manufacturing capacity.

Service in use that is assured by a tie that is easy to handle and install and so designed as to positively hold the rail in place and to correct gauge. The clip action is a patented, exclusive feature which will justify your giving preference to West Virginia Steel Ties. These ties make a safe track that is cheaper in ultimate cost and easier on cars and haulage motors.

**The West Virginia Rail Company**
**Huntington, W. Va.**

**Rails; Mine Ties; Plate Frogs; Solid Steel Frogs; Switch Stands; Switches; Special Track Work; Portable Track; Splices; Angle Bars and Spikes; Reinforcing Bars.**



R-51 "STOPEHAMER DRILL"

# A Stoper Drill with Positive Rotation

With the introduction of the new R-51 "Stopehamer" Drill, the mining and tunnelling world has been given a machine with positive, powerful, automatic rotation.

This drill was developed and perfected because of the urgent need for such a machine. It is the result of experiments over a period of years and is now placed on the market after exhaustive tests under the most severe operating conditions.

The greatest need of positive, automatic rotation was felt in confined raises, narrow veins, tunnels requiring ring drilling, and working places where the high temperature is very fatiguing on the operator.

Rotation is effected by the well-known "Sergeant" Rifle Bar and Ratchet mechanism.

Other features of this new stoper include automatic water feeding device, automatic lubrication to all parts, and push button control of the air feed cylinder.

The drill weighs 106 pounds, is perfectly balanced, and is easy to operate. It has made the drilling of up-holes an easy task.

Write our nearest Branch for full details.

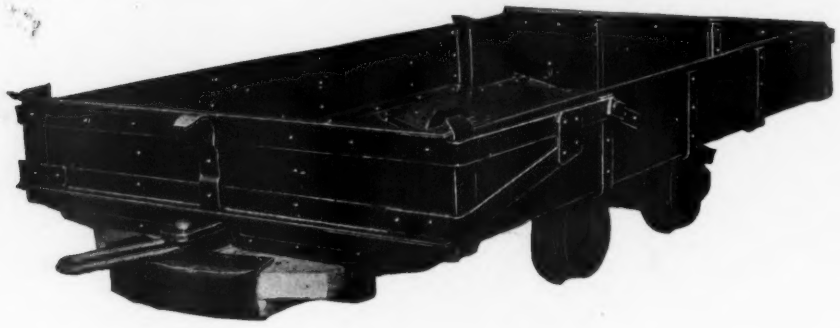
INGERSOLL-RAND COMPANY-11 BROADWAY, NEW YORK CITY.

*Offices in principal cities the world over*

FOR CANADA REFER-CANADIAN INGERSOLL-RAND CO. LIMITED, 260 ST. JAMES STREET, MONTREAL, QUEBEC.

64-SD

# Ingersoll-Rand



# Mining Profit is Linked with Low Cost of Production

MAKING production records is nothing new with Enterprise Cars. They are low in height with great carrying capacity and small maintenance cost.

Low cost of repairs—ease in starting loads—smoothness in running—less friction and consequently less grease, effect additional savings.

Here's a car that meets the problem of the low seam, increases the efficiency of the miner and adds to output with a resultant decrease in the cost-per-ton.

Extra capacity cuts initial cost. Every purchase of mine cars is a purchase of production. Enterprise Cars reduce the cost-per-ton between the loading and the tipple.

"Not a nickel for repairs." Half Mountain Coal Co., Huntington, W. Va.

"Four hundred and ten sets of Enterprise Trucks purchased over a period of seven years and total repair bills amounted to only $11.95." Elkhorn Coal Co., Kenoa.

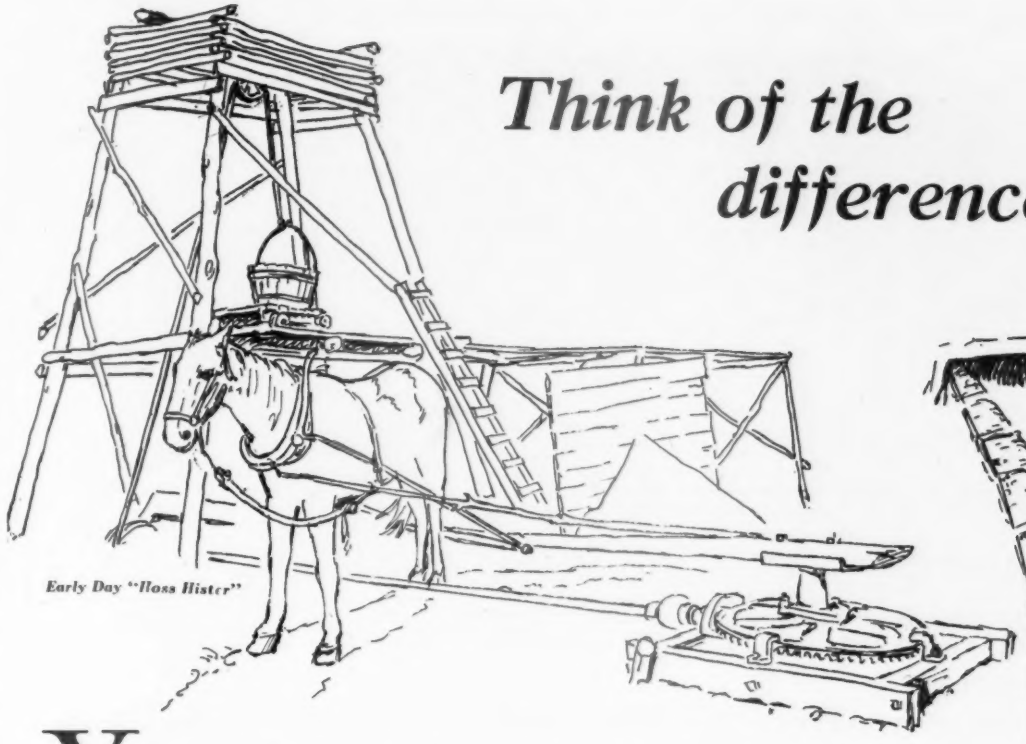
"Our mine is equipped with Enterprise Cars and believe me, they are A No. 1 cars." H. C. Roskey, General Superintendent, Furnace Mining Co.

These are some of the reasons why we can give a five-year absolute guarantee contract with every purchase of car wheels.

We have just issued a most comprehensive booklet on mine haulage containing full details and proof of foregoing statements. The edition is limited—write for one. Ask for "Lower Haulage Costs, Higher Net Profits." It is free to any mine executive or superintendent.

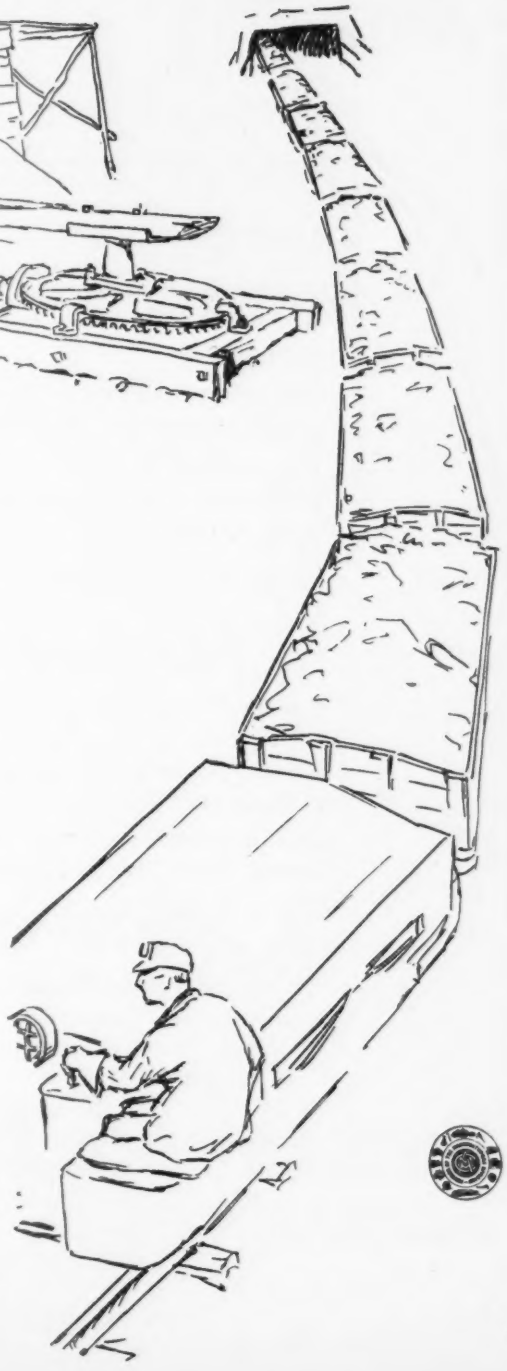
## Enterprise Wheel and Car Corp.

## Bristol, Va.-Tenn. Huntington, W. Va.



*Early Day "Hoss Hister"*

# *Think of the difference!*

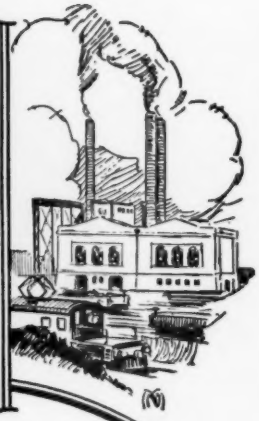


YET the difference between good and indifferent track materials and their efficient layout can still account for a big part of the difference between profitable and unprofitable production. Safety, speed of haulage, car distribution and the amount of rolling equipment required all depend largely upon good track material properly adapted to a mine's requirements. CENTRAL engineers are familiar with all the diverse problems of mine haulage and they are at your service. CENTRAL mine track equipment is well built and designed for long service. Send for catalogue No. 3 and let us help you with your problems.

THE CENTRAL FROG & SWITCH COMPANY
CINCINNATI, OHIO

**CENTRAL**
**MINE TRACK EQUIPMENT**

# Lubrication and Production



IN THE modern industrial world, there is a constant demand for greater and greater speed of production. Present day conditions and keen competition require that every unnecessary delay be eliminated.

Every time a piece of machinery is stopped for repairs, there is a direct loss of money. In addition to the actual cost of the repairs, the production of the machine is lost while it is out of service, and in many cases the operator of the machine is idle until the repair work is completed.

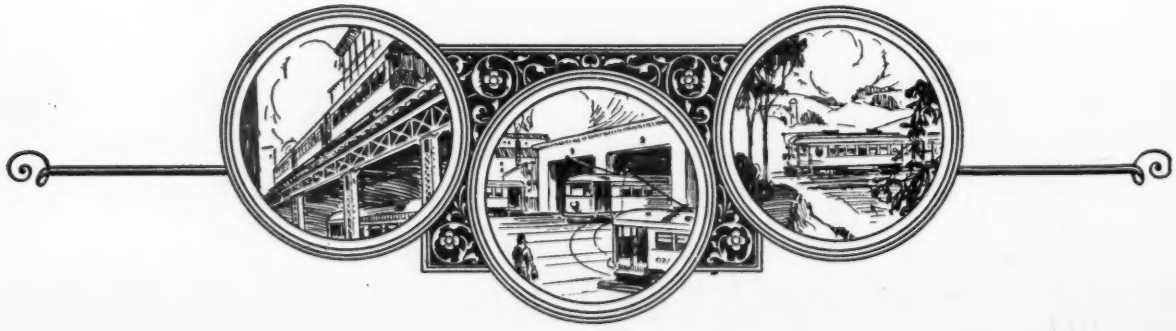
To keep production at the maximum speed in your plant, use

## Standard Oils and Greases

Standard Oils and Greases save your machinery and reduce repair work to the lowest possible point by furnishing correct lubrication. They are made in many grades to suit the lubrication requirements of all machinery used in the industrial world.

Our representative in your city is thoroughly familiar with modern industrial machinery, and will recommend the correct grades for your equipment.

**STANDARD OIL COMPANY**
(Indiana)
**910 South Michigan Avenue Chicago, Illinois**



# Just Hit the Clip!

What could be simpler? Just hit the clip—with any tool that happens to be handy. Carnegie Steel Mine Ties do the rest. And how much more efficiently than the old wood ties! No rotting or deterioration from repeated spikings. So much less labor. Light and easy to carry. So shallow that they save inches of head room (quite important in low seams of coal).

Carnegie Steel Mine Ties are made of copper steel. Wood ties soon rot. Ordinary steel ties rust. But the copper content of Carnegie Ties retards corrosion. Double life!

And finally, Carnegie Ties are economical. Hard to believe, perhaps, when they have so many advantages. Let us prove it to you.

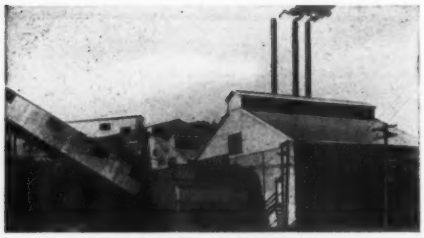
*Booklet—"Steel Cross Ties"—on request*

## CARNEGIE STEEL COMPANY

**General Offices • Carnegie Building • 434 Fifth Avenue**

**PITTSBURGH PENNSYLVANIA.**

1344



COKEDALE WASHERY
American Smelting & Refining Co.

Some Rheolaveur Plants in U. S. A.

Total Annual Capacity

2,185,000 Tons

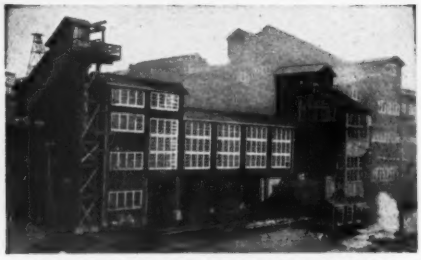
8 Additional Plants

Now Being

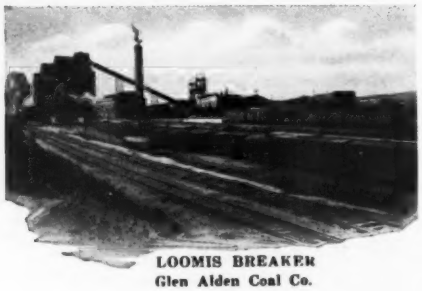
Designed and Erected

Total Annual Capacity

4,200,000 Tons



SILT PLANT, GOOD SPRING BREAKER
Philadelphia & Reading Coal & Iron Co.



LOOMIS BREAKER
Glen Alden Coal Co.

About 200

Rheolaveur Installations

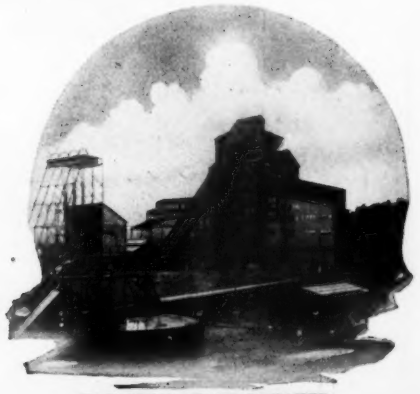
Throughout the World

Total Annual

Capacity

60,000,000 Tons

LATTIMER No. 6 BREAKER
Pardee Bros. & Co., Inc.



HAZLETON SHAFT BREAKER
The Lehigh Valley Coal Co.

**American Rheolaveur Corporation**

NEW YORK OFFICE
120 Broadway

WILKES-BARRE OFFICE
911 Coal Exchange Bldg.

# Keystone Grease Is the Working Mate of POWER!

The power for which in some form or other you pay, is pitted against two opposing conditions.

One is the force of Gravity—an honest adversary that gives and takes.

The other is Friction, a mechanical parasite, that exists only on the absorption of Power.

Keystone Grease will decrease friction and its kindred evils of excessive wear. In comparison with other lubricants, Keystone Grease costs slightly more per pound, **but vastly less per year.**

*Write for literature giving facts that will save you money*

## KEYSTONE LUBRICATING CO.

*21st and Clearfield Streets* *Philadelphia, Pa.*

*Established 1884*

KEYSTONE
TRADE MARK
Reg. U.S. Pat. Off.
GREASE

# You Can *Always* *Get* YARMOR

The supply of YARMOR Steam-Distilled Pine Oil is *dependable.* No matter how much you may want, you can get it. For YARMOR is manufactured in large plants, with capacity to supply all the pine reagent requirements of the country. Write for a free copy of "Hercules Flotation Oils."

**HERCULES POWDER COMPANY**
*(INCORPORATED)*

962 Market Street, Wilmington, Delaware

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***Hercules Powder Company***
***962 Market Street***
***Wilmington, Delaware***

***Please send me descriptive booklets on Hercules Flotation Oils.***

***Name***.....

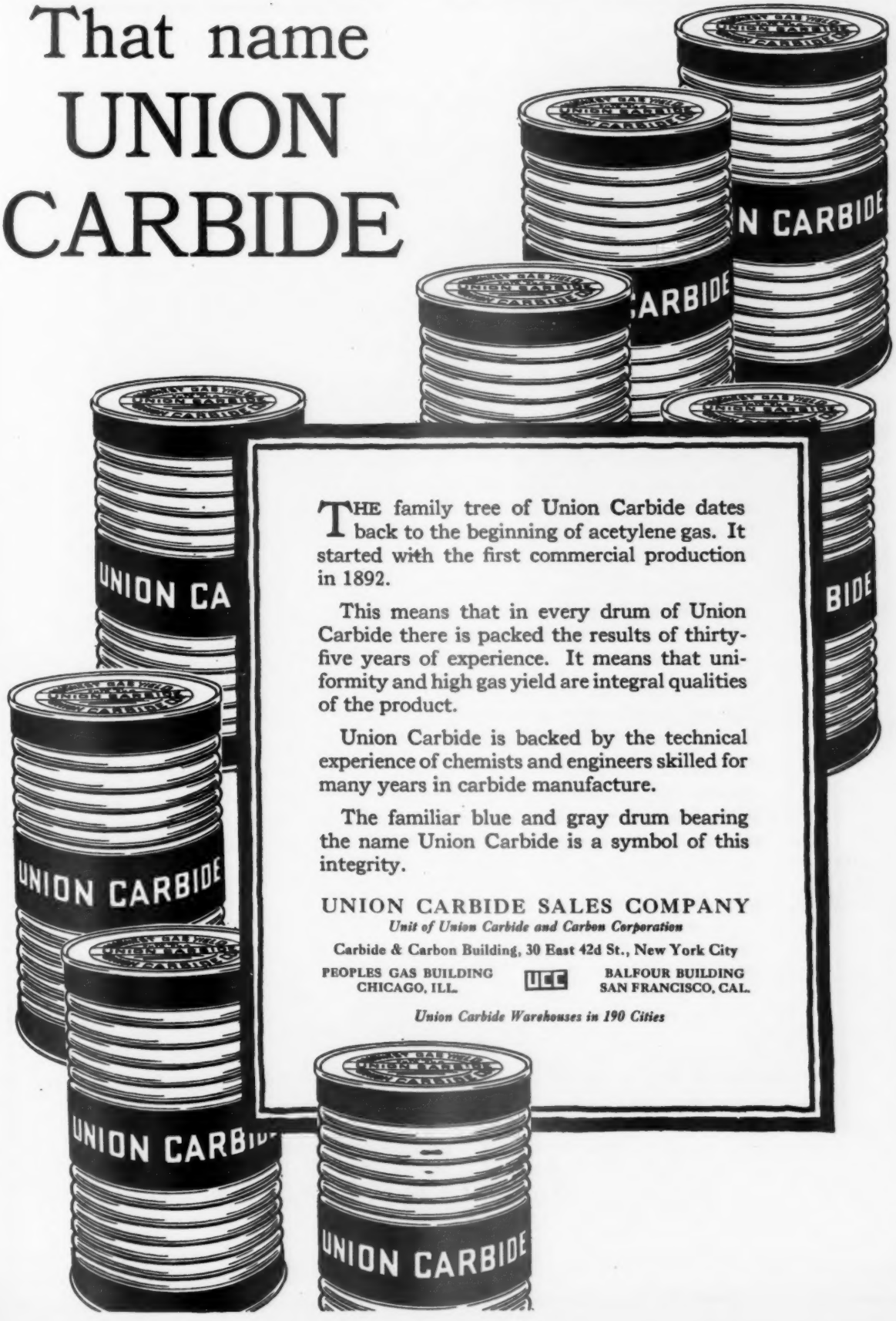
***Company***.....

***Street***.....

***City***.....

***State***.....

# That name UNION CARBIDE




THE family tree of Union Carbide dates back to the beginning of acetylene gas. It started with the first commercial production in 1892.

This means that in every drum of Union Carbide there is packed the results of thirty-five years of experience. It means that uniformity and high gas yield are integral qualities of the product.

Union Carbide is backed by the technical experience of chemists and engineers skilled for many years in carbide manufacture.

The familiar blue and gray drum bearing the name Union Carbide is a symbol of this integrity.

UNION CARBIDE SALES COMPANY

*Unit of Union Carbide and Carbon Corporation*

Carbide & Carbon Building, 30 East 42d St., New York City

PEOPLES GAS BUILDING
CHICAGO, ILL.

UCC

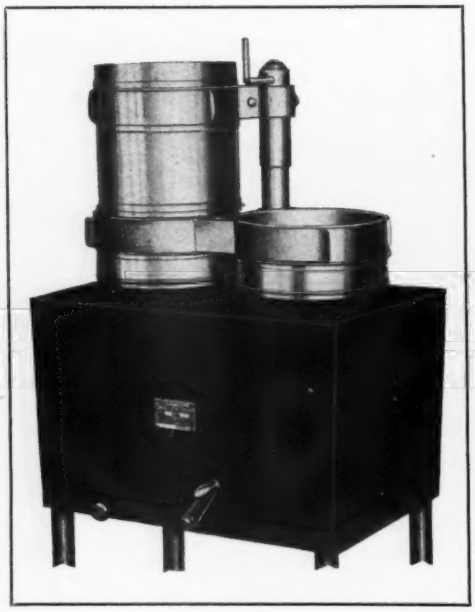
BALFOUR BUILDING
SAN FRANCISCO, CAL.

*Union Carbide Warehouses in 190 Cities*

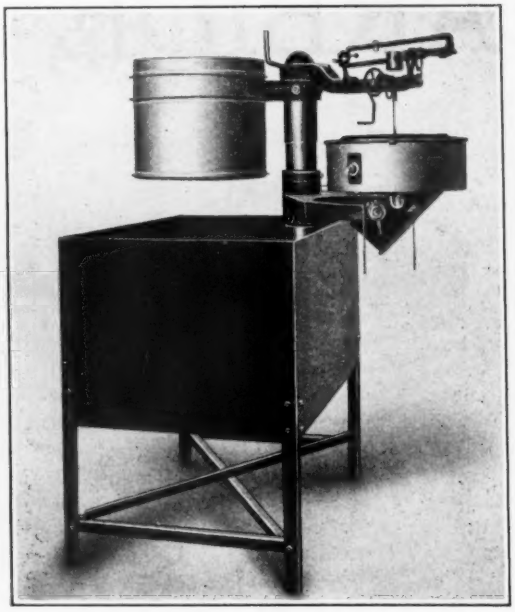
THE

# DELATESTER

(REG. U. S. PAT. OFF.)



*Size 10*
*For Ten-pound Samples*



*Size 20*
*For Fifty-Pound Samples*

During the recent CONVENTION OF PRACTICAL COAL OPERATING MEN at Cincinnati, held under the auspices of The American Mining Congress, several of the speakers stated that the DELATESTER was used for the control of the operation of their coal cleaning plants.

Practically every dry cleaning plant in the United States and Canada, and a great many of those employing wet processes, are equipped with DELATESTERS.

The use of the DELATESTER assures plant operation at maximum efficiency. The following list of companies that are using the DELATESTER is convincing evidence of this and of the great value of this machine to the Coal Industry.

Bethlehem Steel Co.
Youngstown Sheet & Tube Co.
Woodward Iron Co.
Republic Iron & Steel Co.
American Smelting & Refining Co.
Sloss Sheffield Steel & Iron Co.
Birtley Iron Co. (England)
Pittsburgh Coal Co.
The Berwind-White Coal Mining Co.
The Hudson Coal Co.
Lehigh Valley Coal Co.
Glen Alden Coal Co.
Northumberland Mining Co.
Colonial Colliery Co.
Grand Tunnel Coal Co.
American Coal Co.
Greenbrier Coal & Coke Co.
Ashland Coal & Coke Co.
Southern Coal & Coke Co.
Black Diamond Coal Mining Co.
International Coal & Coke Co. (Canada)
McGillivray Creek Coal & Coke Co. (Canada)
Brazeau Collieries Ltd. (Canada)
American Coal Cleaning Corp.
Roberts & Schaefer Co.
Deister Concentrator Co.
Link Belt Co.
Elk River Coal & Lumber Co.

*For prices and further information write to:*

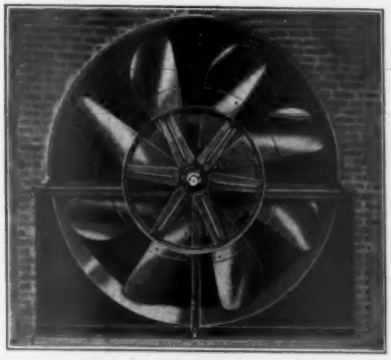
## G. R. DELAMATER

11841 Lake Avenue, Cleveland, Ohio, U. S. A.

*(After October 1, 1927—address will be 3233 Chadbourne Road.)*

# ROBINSON FANS

## FOR EVERY PURPOSE



**ROBINSON CONIFLO MINE TYPE DISC FAN**

Notice the heavy construction of the fan. Wheel is mounted between two Ball or Roller Bearing Pillow Blocks, Standard Equipment. Capable of high speeds and of good efficiency. Carried in stock at Factory at all times.

**ROBINSON TURBINE TYPE WHEEL**

No tie rods are necessary to support wheel. These wheels are made in sizes from 12-inch diameter to 25 ft. diameter. They are made special to meet the conditions required of them.

**ROBINSON AUXILIARY CENTRIFUGAL FANS**

Used for primary fans on small mines or auxiliary fans inside larger mines. Notice the unit construction, making these fans easily portable. Made in any size required.

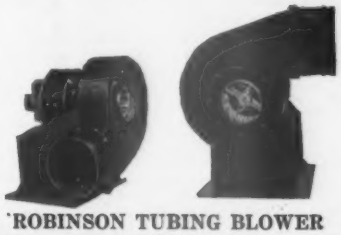
**ROBINSON PORTABLE KILN KOOLERS**

**ROBINSON PORTABLE KILN ACCELERATORS**

**ROBINSON REVERSIBLE MINE FAN**

This can be purchased with or without the steel air drift side wall, roof plate and hood over shaft. Hood equipped with explosion doors. Full steel housing, ⅜ or ¾ steel housing. This can be arranged for extended drives, with drive on either side or two drives on one side. All Robinson Reversible Mine Fans are constructed so that they are efficient when either blowing or exhausting. They are scientifically designed and constructed to give you the most efficient installation possible. All doors are packed to prevent leakage of air.

All our centrifugal fans are built to order the same as the tailor makes your suit to order. This is the reason they fit your mine.



**ROBINSON TUBING BLOWER**

For use in the mine with flexible tubing or sewer pipe to conduct the air. Structural steel motor base with casing arranged for eight different angles of discharge. Inlets protected with safety guards. Outlet constructed of Cast Aluminum; fan wheel constructed of Cast Aluminum up to and including the No. 3 size. Write for special bulletin.

We manufacture the FAMOUS ROBINSON MAN COOLING FAN PRESSURE BLOWERS FORCED and INDUCED DRAFT FANS

**ROBINSON**
ZELIENOPLE Ventilating Co. PENNSYLVANIA

A. J. MOORSHEAD
PRES. & GEN'L MANAGER

F. H. WOLFARTH
SECRETARY & TREASURER

## Madison Coal Corporation

General Offices, 910 South Michigan Blvd., Chicago

Glen Carbon, Illinois, April 5, 1927.

American Mining Congress,
Washington, D. C.

Gentlemen: Attention: E. R. Coombes, Sec'y.

Please accept my thanks for the copy of "American Standard on Wire Rope for Mines". It contains more real data of value than any wire rope manual I have ever seen and no doubt furnishes just the information desired by most mining men.

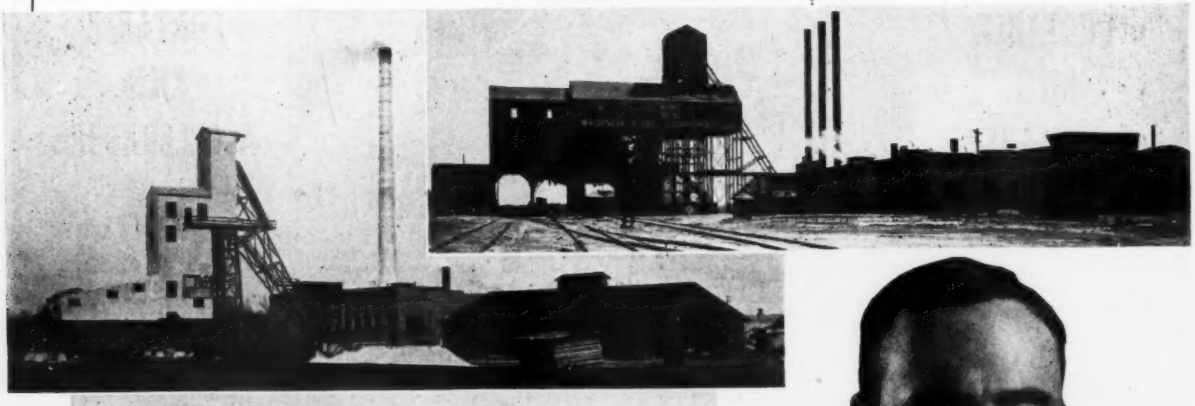
Yours truly,

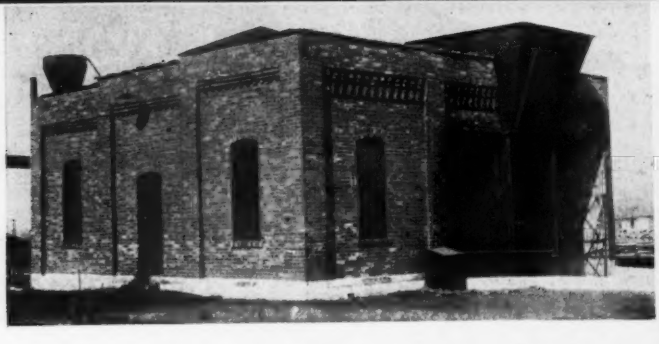
D. W. Blaylock

DWB:S Mining Engineer

**The Madison Coal Corporation is the coal department of the Illinois Central Railroad and operates eight mines in Illinois and Kentucky. The total daily capacity is approximately twenty-one thousand tons. All are shaft mines except one, and are located on the Illinois Central Railroad. The seams of coal worked are the No. 6 in Illinois and the No. 5 in Kentucky.**

**The mines are electrically equipped throughout and every effort is made to prevent accidents**





*General views of two of the plants of the Madison Coal Corporation. Right, the plant at Divernon, Ill., and, left, tipple power house and shop buildings at Mine No. 12, Cambria, Ill. Below, reversible 16' x 5' fan at Divernon.*

**D. W. BLAYLOCK**
**Chief Mining Engineer**

# "more real data of value than any wire rope manual"

THIS specific and unstinted commendation of the new Wire Rope standards is typical of the disinterested and spontaneous praise that greets the release of each new section of the Handbook, praise that comes from operating men in every coal mining section of the country. And there is good reason why the subjects covered should be inclusive and conclusive. The book is the result of seven years intensive and unselfish research on the part of three hundred and fifty thoroughly representative operators, engineers and manufacturers. It is condensed and authoritative. It is cooperatively backed by the leading engineers and mining equipment manufacturers of the country.

It is presented in practical working form and is kept up to date as new recommendations are approved. It is a textbook of progress in coal mining practice. It is supplemented by the discussions in The Mining Congress Journal. Have you a copy for each of your key men? It is a paying investment.

**IMPORTANT SUBJECTS TREATED** in the Handbook of Standard and Approved American Coal Mining Practice include: basic rules safeguarding electricity in mines; electric tipple equipment; underground stations (all phases of automatic control of mine equipment); trolley and storage battery type locomotives; mine tracks, signals, and switches, including track gauge, turnouts, frogs and switches; mine cars; mine fans; airways and shafts and booster fans; wire rope, ladders, and miscellaneous coal handling equipment; pumps for development work, permanent pumping stations, natural drainage, and effect of mine water on equipment; loading machines, belt, chain and shaking conveyors, installing and operating cutting and loading equipment; general mine timbering, preservation of timbers, and use of concrete and steel.

*This Handbook is pocket size, loose-leaf, and will be kept up-to-date as recommendations are approved. Its price is $5. This includes a subscription to The Mining Congress Journal. For further information, address The American Mining Congress.*

STANDARDIZATION
DIVISION,

The American Mining Congress,
841 Munsey Building, Washington, D. C.

I am enclosing.....for.....copies of the Handbook of Standard and Approved American Coal Mining Methods, Practice Equipment—each order to include a subscription to The Mining Congress Journal.

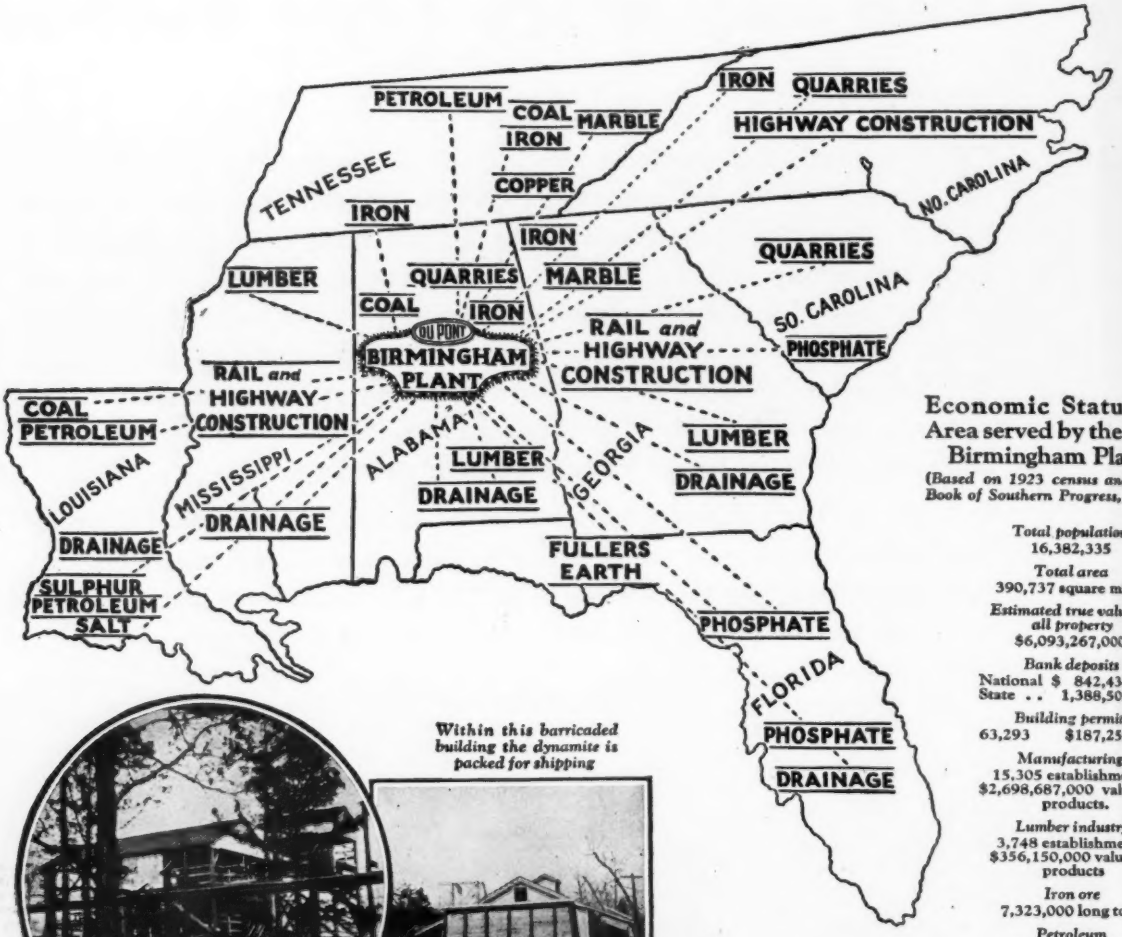
Name .....

Street .....

City..... State.....

A SERVICE OF THE - - - AMERICAN MINING CONGRESS

# For the




**Economic Status of Area served by the new Birmingham Plant**

*(Based on 1923 census and Blue Book of Southern Progress, 1924.)*

*Total population*
16,382,335

*Total area*
390,737 square miles

*Estimated true value of all property*
$6,093,267,000

*Bank deposits*
National $ 842,434,000
State .. 1,388,502,000

*Building permits*
63,293 $187,250,579

*Manufacturing*
15,305 establishments
$2,698,687,000 value of products.

*Lumber industry*
3,748 establishments
$356,150,000 value of products

*Iron ore*
7,323,000 long tons

*Petroleum*
32,476,000 bbls. of 42 gallons

*Coal*
24,300,000 short tons

*Phosphate rock*
2,413,402 tons sold
Value $10,463,154

*Fullers' Earth*
Florida, leading producing state, 64,122 tons. Value $1,122,940. 64% of total output, 49% of total value for 1922.
Georgia second producing state.

*Highway Expenditure*
$99,504,688

*Building where nitric acid recovery is effected*

*Within this barricaded building the dynamite is packed for shipping*

*Housing the nitroglycerin manufacturing apparatus*

125 YEARS OF LEADERSHIP IN THE SERVICE OF INDUSTRY

# INDUSTRIAL SOUTH . .

*A panoramic view of a section of the Birmingham Plant*

## a *concentrated* power plant

ANOTHER kind of power plant for one of the richest industrial corners of the world, keyed to its rapid development. Another sort of Muscle Shoals—the new Birmingham Plant of E. I. du Pont de Nemours & Co.—with an annual capacity of 15,000,000 pounds of explosives—15,000,000 pounds of *concentrated power.*

This new manufacturing unit, for the service of an area of close to ten billion dollars' economic value, is located 12 miles northwest of Birmingham on the Louisville & Nashville Railroad. Within an area of 1280 acres are contained the most modern explosives manufacturing plant with machinery and equipment, the finest laboratory—factory units that represent 125 years of explosives experience and knowledge.

A huge concrete dam impounds approximately 65,000,000 gallons of water to insure an adequate water supply.

To maintain the highest quality of product, excess moisture is kept out of explosives by conditioning the air in all "dope" and powder manufacturing buildings. Ten thousand feet of broad gauge railroad trackage speed materials from building to building, and the finished products to shipping points and magazines.

The complete line of du Pont dynamites and gelatin dynamites are manufactured in the Birmingham plant. Distributing facilities are also provided for blasting supplies and black powder. Typical of du Pont nation-wide explosives service.

**E. I. DU PONT DE NEMOURS & CO., Inc.**

*Explosives Department*

WILMINGTON, DELAWARE

Birmingham Huntington Pittsburgh Chicago St. Louis

# Eickhoff

JIGGING CONVEYOR

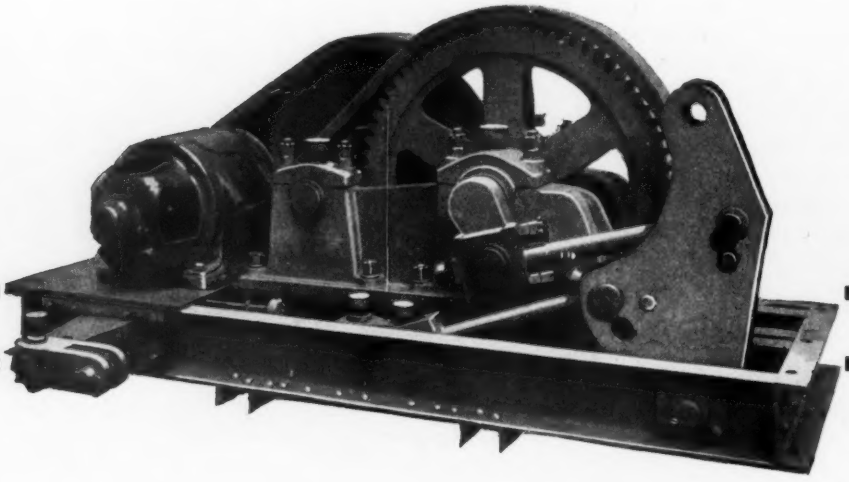
## "MRA" ELECTRIC DRIVE

FOREMOST in conveyor operating capacity in the Eickhoff group of 5 Electric and 5 Air Machines, the MRA is the most powerful electric jigging-conveyor drive obtainable.

Supplied for extra heavy work, the MRA is giving satisfactory service in thousands of installations throughout the world—in many of which it is regularly handling loads that are far beyond the capacity of any other drive built.

Eickhoff Drives, in combination with Eickhoff Conveyors and Automatic Loading Attachments, enjoy a reputation for superiority that is the result of many years of successful operation in European and American mines.

*Write for Booklet 559*



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**MINE SAFETY AND MINE SAFETY CODES**

THE RECENT CONFERENCE called at Cincinnati to discuss the feasibility and advisability of a national mine safety code called renewed attention to the question of mine safety. An examination of the statistical data with relation to accidents developed some interesting facts which are worthy of special attention.

The U. S. Bureau of Mines was organized with particular reference to mine safety and grew out of the increasing accidents, particularly those in bituminous coal mines.

For several years prior to 1907 the ratio of accidents had been increasing at a rapid rate, culminating in that year with a ratio of fatalities of 6.78 per million tons of coal produced.

The public interest in safety developed by the propaganda leading to the creation of the Bureau of Mines immediately made itself manifest in the reduction of mine accidents, resulting in a gradual and almost uniform reduction year by year from 6.78 in 1907 to 3.77 in 1916. This public movement lead to the development of many splendid mine safety organizations by various mining companies, which have continued to function with increasing benefit down to the present time.

An apparent recession of this public interest, beginning with the opening of the World War, has resulted in a second ten-year period in which there seems to have been no substantial gain. From the loss ratio of 1916 of 3.77, the ratio has grown to 3.79 in 1926, with an average loss ratio of 3.92 for the ten-year period. This record indicates an increase in the loss ratio in the bituminous coal mines of the country, notwithstanding the excellent records made by many large companies who have created safety organizations which not only provide all of the means for accident prevention but who are continually working with their men to inspire greater care in guarding against accidents.

The bituminous coal industry is specially cited only because of the fact that its statistics have been better and longer kept. In other branches of mining the record apparently supports the same theory.

Based on one thousand 300-day workers the fatal accident record for 1924 is as follows:

| | |
|---|---|
| Non-metallics | 194 |
| Lead and zinc (Mississippi Valley) | 276 |
| Iron | 295 |
| Copper | 355 |
| Gold and miscellaneous metals | 499 |
| Bituminous coal | 439 |
| All mining industries except coal | 351 |

This record seems to indicate that the failure to still further decrease our loss ratio grows very largely from the carelessness of those who are the greatest sufferers, and that there is need of a reconsecration to the work of safety.

It is but natural for one who is continually in contact with danger to become careless, and it therefore becomes necessary that continual reminders shall be urged in order to prevent recklessness.

Many mine operators are fully awake to the necessity of mine safety appliances and mine safety organizations. These have been installed and developed to an extent which should give us a better loss record than that of the past ten years.

We urge renewed activity in this behalf and hope that the next ten-year period may correspond to the period from 1907 to 1916 in its proportionate decrease in mine accidents.

**THREE SYNONYMOUS WORDS**

THREE SYNONYMOUS WORDS—patience, persistence, progress—sum up accurately a movement that has grown with amazing rapidity in a comparatively short period.

While it is true that the American Mining Congress has for a period of 15 years been developing the convention-exposition idea, and has expended a vast amount of energy and resources in educating the mining industry as to its value, it has remained for those meetings scheduled annually at Cincinnati to justify all of the expense, all of the grief, all of the arduous labor that has attended the perfection of such a meeting as the one just closed.

More than $3,000,000 worth of equipment was exhibited under one roof, while under that same roof there assembled more than 3,000 men, each ready and willing to contribute of his experience, knowledge and ability in the solving of the production problems of an industry that is already a world wonder for efficient extraction of its product.

It has taken patience; it has taken persistence; the constant reiteration of a principle; the unceasing effort of at first a few, then many men, to spell that word "progress" for the coal mining industry.

Great success was attained during the week of May 16. Progress was emblazoned as never before upon the banner of the coal industry. Marvelous progress in the arts of coal preparation and of mechanical mining were recorded. Results attained through experimentation mean millions of dollars to the consumers of coal, through the more efficient production of this commodity already produced more cheaply in this country than by any nation in the world.

Success is an unsteadying thing. But the mining industry will accept it in true spirit only as an incentive to greater effort. The industry is just beginning to feel the power of these meetings; only now beginning to reap the result of the patient, persistent effort that spells—Progress.

**DEPLETION STUDY**

AMONG THE SUBJECTS to be studied by the Joint Congressional Committee on Internal Revenue Taxation is that of depletion of mines. Experience of more than a decade in the administration of the depletion provisions of the income tax law has not resulted in the simplification of methods of determining depletion allowances, except in the case of the oil industry. The Revenue Act of 1926 provided in the case of oil and gas wells that depletion allowances would be an amount equal to 27½ percent of gross income, subject to the limitation that the allowance on this basis in any case shall not exceed 50 percent of the net income from the property, but subject also to the further provision that the allowance in any case shall not be less than it would be if computed on the bases of cost or March 1, 1913, value.

The comparative simplicity of determining allowances in the oil industry on the basis of a percentage of gross income has been apparent in the adjustment of returns of oil companies under the 1926 Act, and has caused those engaged in the investigation of the internal revenue system to wonder if such a basis would not also be practicable for mines, especially if the mining taxpayer is given the same alternative that the oil taxpayer has of taking depletion on cost or March 1, 1913, value, whichever may be available to him, where the percentage basis gives a less amount. Accordingly, the Division of Investigation of the Joint Committee is undertaking to assemble all facts that may be of assistance in dealing with the matter from a legislative standpoint. No one has any preconceived notion about what these facts will show, except that in the case of coal mines information already available indicates that depletion allowances have been exceedingly low, and possibly below what Congress intended when it provided in the law for "a reasonable allowance."

The Supreme Court in the *Ludey case* said that depletion is to be regarded as a return of capital, not as a special bonus for enterprise and willingness to assume risks. The court called attention to the difficulties involved in estimating the value of the mineral contents of the reserves from which the product is taken, which are recognized as wasting assets; but said that "Congress concluded, in the light of experience, that it was better to act upon a rough estimate than to ignore the fact of depletion." The court likened depletion to the using up of raw material in making the product of a manufacturing establishment. As the cost of the raw material must be deducted from the gross income before the net income can be determined, so the estimated cost of the part of the mineral reserve used up is allowed.

Congress provided for depletion of oil wells on the basis of a percentage of gross income on account of the difficulties presented in estimating the value of such wells. It was recognized that valuations in most cases were unsatisfactory—either to the Government because its engineers believed the taxpayer's estimated reserves were too large, or to the taxpayer because he believed the estimates allowed by the Government's engineers were unduly low. Perhaps the same situation will be found in the case of coal and metal mines. Perhaps the study being undertaken by the engineers of the Joint Committee will enable Congress to provide in the next revenue act for a percentage basis that will simplify the problem, and at the same time give to taxpapers, who for one reason or another have been unable to establish a basis for depletion adequate to amortize their investment during the life of their properties, "a reasonable allowance for depletion."

The American Mining Congress has always regarded depletion as a return of capital, and could not support any proposal that might jeopardize the rights that taxpayers now have of taking depletion on the bases of cost, March 1, 1913, value, or discovery value. The Mining Congress has held consistently to the proposition that taxpayers engaged in mining are entitled to depletion to cover return of capital by reason of exhaustion, whether that capital existed at March 1, 1913, or was invested subsequent to that date in connection with the purchase of mining property, or was acquired subsequent to that date as the result of discovery of a mineral deposit of commercial value. An investigation of the whole subject should at least result in administrative simplification, whether Congress finds justification for experimenting with a percentage basis in the case of mines or not. In the meantime, the mining industry has no reason to be alarmed, as it is believed the Joint Committee contemplates only such action as will be agreeable to both the taxpayers and the Treasury.

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**BETTER COAL PREPARATION**

BETTER AND MORE COMPLETE coal preparation is developing rapidly. The interest in the three sessions of the Cincinnati convention where Coal Preparation was the topic for discussion, proved conclusively just how seriously the industry is considering this subject.

Over-development of the coal industry has placed the consumer in a position to select better grades of coal. This is forcing the producer to adopt better preparation and cleaning methods. Very few seams are so free of impurities that no cleaning is required. In the past the slate picking that was done by the miner at the face was considered adequate, and where a small percentage of impurities occurred in such small pieces that they could not readily be removed by hand, they were in many cases left in, and went to the consumer.

A growing tendency of the consumer now is to demand clean coal in all sizes, and to contract for his coal on ash guarantees. Those mines where seams are not exceptionally clean are being forced to consider and adopt preparation methods and equipment that will enable them to meet competition, which is but another example of attaining fitness in order to survive.

Many mines have already installed picking tables and shaking screens that several years ago had no need or trade demand for these devices. The anthracite industry developed cleaning methods long ago and has gone considerably further in solving its preparation problems than has the bituminous industry. But bituminous mines are now developing their methods, and several of the newer plants were described at Cincinnati. The papers presented at this meeting all point to the necessity for special study before cleaning methods are adopted, as each mine or seam requires special treatment.

Every form of coal cleaning used today was described. The papers appear in full in this issue. Never before has such a symposium of data on coal cleaning been assembled. By careful study of these papers and of the results obtained under varying conditions, any operator may more or less accurately determine what process will meet his condition.

**GOOD GOVERNMENT SUSTAINED**

THE DECISIONS OF THE SUPREME COURT upholding the constitutionality of the criminal syndicalism acts of the States of California and Kansas, and sustaining a conviction under the California act, will be approved by the American public generally. The public has been distressed time and again by the flagrant abuses of the rights of free speech, teaching and assembly by radicals who denounce our Government and who give allegiance to both domestic and foreign organizations that advocate crime, violence and other unlawful acts or methods as a means of effecting political or industrial changes or revolution.

The public not infrequently has been horrified by such events attending strikes as the Herrin massacre, which invariably have been incited by radicals who have claimed immunity from arrest and punishment. In many instances it has seemed that the state governments might have prevented such occurrences by restraining the activities of those advocating force and other illegal methods of accomplishing their purposes. But our state governments have been exceedingly lenient in such matters. Under no other system of government in the world has such freedom of speech, action, and association been permitted as has existed in this country.

In carrying on their propaganda and agitation against so-called capitalism, radicals have in the past resorted to every trick, practice and subterfuge, and every sort of criminal attack and action that would tend to stir up the populace and sway the ignorant and gullible. Dynamiting, sabotage, arson, murder, and similar offenses and outrages have accompanied strikes and labor disturbances whenever these advocates of social, political and economic revolution have been permitted to carry on their nefarious activities among the striking masses. The general public has grown weary of this sort of thing, especially as conditions enjoyed by the masses in this country are so far superior to conditions and standards of living anywhere else in the world.

Thus, it is reassuring to know that measures taken in various states to protect the state from serious injury or destruction—political, economic and moral—are not in conflict with the Federal Constitution. Under these decisions, individuals are protected to this extent—they can not be punished solely because they are members of organizations that are disreputable. The state must charge a crime and prove the charges. In the Kansas case the state failed to charge or prove that the organization in which the defendant secured members advocated any crime, violence or other unlawful acts. In the case of the defendant Whitney, convicted under the California statute, the Supreme Court held that the question as to whether or not the conviction was supported by the evidence was foreclosed by the verdict of the jury and not subject to review.

The court holds that for individuals to combine in an association for the accomplishment of the desired ends through the advocacy and use of criminal and unlawful methods, partakes of the nature of a criminal conspiracy, and that it is clear that such united and joint action involves even greater danger to the public peace and security than the isolated utterances and acts of individuals. Members of such an association are not protected from punishment by the due process clause, and their rights of free speech, assembly or association are not unwarrantably infringed upon by the state in exercising its police power to restrain activities that menace the peace and welfare of the state.

The radical is not discriminated against. He has the same rights as any other individual or citizen. However, the I. W. W.'s, the communists, the bolshevists, and others who regard freedom as a license, and to whom "dictatorship of the proletariat" means more than "government of the people, by the people, and for the people," will find in these decisions of the Supreme Court a bill of rights that is wholly unsatisfactory. The public generally will applaud the court for its action.

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**COOPERATION FOR TAX RELIEF**

FOR A NUMBER OF YEARS The American Mining Congress has advocated cooperation between agricultural and industrial organizations in studying state and local tax problems, and in formulating and carrying out measures for securing tax relief. Such cooperation has become absolutely necessary in order to curb extravagance in state and local expenditures and to slow up the rapidly mounting total of state and local indebtedness which imposes enormous fixed charges upon the public revenues derived from taxation. The National Industrial Council, composed of more than 300 associations of manufacturers, local, state and national, is vigorously promoting the idea.

The movement that is now well under way, known as "Better Understanding Between Industry and Agriculture," and the efforts of its present protagonists to secure cooperation between intra-state groups for "mass" action in controlling state and local expenditures and taxation, are accomplishing results that are exceedingly gratifying. This movement has been approved by such national organizations as the National Grange, the American Farm Bureau Federation, the National Association of Manufacturers, and the National Founders' Association, and it is reported that farm and industrial organizations in twenty-six states have already arranged for close cooperation and intensive work in connection with local tax problems.

Responsibility for state and local expenditures is now widely diffused. For that reason, it is necessary for taxpayers to organize locally, irrespective of industry or occupation, in order to exert pressure for efficient administration of the public business and reduction of public expenditures to the lowest minimum consistent with the public welfare. Wherever such a local movement is started, local mining interests are urged to cooperate. State and local taxation and indebtedness is now a national problem; but the only practicable solution for it seems to be in collective action by state and local industrial groups acting in their particular state or locality.

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**THE COME-BACK OF GERMANY**

Every industrious, intelligent and thrifty individual possesses the power to overcome all financial and industrial difficulties. As with individuals, so with nations.

Reports from Germany indicate that, having given up her hope of evading the obligation apportioned to her by the Dawes Commission, she is now staging an industrial come-back which promises to be a surprise to many who felt that she could not make progress unless all of her obligations were cancelled.

For a few years after the war under the stimulus of cheap currency, Germany experienced a great industrial activity but the very worthlessness of the money with which labor was paid prevented that benefit to the Nation which would have accrued with a stabilized currency system.

Since the acceptance of the Dawes plan, Germany has gradually moved toward a stable financial position; she has stabilized her currency, balanced her budget, and her people have gone to work. Not only has the output per man been largely increased, but the number of unemployed men has very largely decreased.

In the year 1920, through the result of labor strikes, the number of working days lost amounted to 54,207,000 days. During the year 1926 the loss was but 1,022,000 days. Increased employment and increased production per man will open the doors of foreign markets; will climb over protective tariff walls, and bring prosperity.

No nation need be discouraged unless the interest upon her foreign debt is greater than the surplus earning power of her people.

When other European nations shall spend less time in discussing the possibilities of avoiding their obligations and more in productive effort, each in turn, will be enabled to look to a brighter future.

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**THE GROWTH OF MECHANICAL MINING**

FIGURES ON THE GROWTH of mechanical mining given by Dr. L. E. Young, vice president, Pittsburgh Coal Company, at the recent Cincinnati meeting, are both amazing and gratifying. In 1923 we mechanically loaded approximately 2,000,000 tons of coal; in 1924, 3,500,000; in 1925, 6,250,000. The figures for 1926 are not available, but a very conservative estimate is that we mechanically handled approximately 9,000,000 tons, with figures mounting steadily as 1927 progresses. It was also brought out that a sufficient number of machines have already been installed to mechanically load 1,000,000 tons monthly.

G. B. Southward, mechanization engineer for the American Mining Congress, reported that of the 35 bituminous coal mines using mechanical loading visited by him during the past six months, at least 27 are obtaining highly satisfactory results under varying conditions.

Papers read before the meeting described successful mechanical loading, scraper and conveyor mining operations. They illustrate how these classes of equipment are being applied to various seam conditions and mining systems. These papers describe the development that has now been reached and are particularly valuable in placing before the industry the experience that has already been gained. It is to be noted that they tell of the difficulties that have been encountered, as well as the success attained. There was no tendency to give the impression that mechanized mining is simply a matter of purchasing and installing equipment. In fact, it was distinctly brought out that mechanization requires thought and study, but with proper and intelligent approach to the problem success may be attained.

Mechanical mining is destined to be the biggest factor in future coal production. Meetings, such as the Cincinnati convention, are rapidly making available to the industry sound facts and information that will enable intelligent progress with a minimum of expenditure of both money and time.

**A PIONEER OF THE SKY**

BACK OF ALL THE MARVELOUS ACHIEVEMENTS of the American Nation stands a grand array of pioneers. Pioneers in agriculture, pioneers in railroading, pioneers in mining, pioneers in motor transportation, pioneers in power development, pioneers in wireless communication, pioneers in manufacturing, pioneers in flying, and what not. Western civilization leads the world in evolving new ideas, inventions, and methods of utilizing raw materials, in scientific research and exploration, and in launching out into unknown paths; in other words, in doing the impossible.

We have had many pioneers of the sky whose achievements are unexcelled, among whom Capt. Charles Lindbergh now takes a stellar position. To say that the whole world was electrified by Lindbergh's feat in virtually jumping across the Atlantic Ocean from New York to Paris expresses only mildly the thrill that shot through the hearts of those who waited breathlessly for the news. We rejoice in Lindbergh's triumph, though saddened by the loss of those gallant Frenchmen who made the attempt and failed.

The feat of the youthful Lindbergh should serve as an inspiration to the youth of America and of the world, and as a demonstration that the field of human conquest lies ahead and in the realm of the unknown, where pioneers are needed, where competition means nothing, and where the opportunities for and the rewards of success are without limitation.

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**WHERE CREDIT IS DUE**

A LEADING COAL OPERATOR paid a very fine and justified compliment to the manufacturers of mining equipment at the recent Cincinnati meeting when he said. "The supply business has unselfishly done our engineering for us. It has done our thinking for us, and it has done more to develop the cheap mechanical mining of coal, than all the coal operators and all the miners put together. They have done it gladly and they will continue to do it."

That, we believe, is a sentiment largely shared by mining men. It has always been the inventor, the manufacturer, who has pointed the way to cheap production. In many instances in the mining industry the inventor has also been the coal operator. Without inventive genius, the mining industry — all industry — would stagnate.

No group of manufacturers are entitled to take more credit in that tribute than the members of the Manufacturers Division of The American Mining Congress. A comparatively small group of manufacturers, under the leadership of that organization, immediately appreciated the value of the idea of the bringing together of the manufacturer and the operator in public conclave, where each might discuss those things that each felt would bring greater return to the industry in safety, in production capacity, and in financial emoluments, and gave the idea their moral and financial endorsement.

With the fourth successive year that the Cincinnati meetings have been held, surely there is none left that will challenge their importance, none to say that this group of men were not far-seeing, and none, whether he be operator or manufacturer, who will not gladly contribute his help in making this type of cooperative effort even more effective.

# FOURTH ANNUAL MEETING PRACTICAL COAL OPERATING MEN

***Progress In Mine Mechanization A Major Theme Of Great Gathering—Coal Preparation Discussed At Three Sessions—Safety Measures Endorsed—Better Blasting Practice Discussed—Greatest Exposition Mine Equipment Ever Assembled***

THE Fourth Annual Convention of Practical Coal Operating Men just closed at Cincinnati marks more than an epoch in coal production history. It heralds the "Dawn of a New Era"—that of mechanization of the mines. That the industry is getting down to brass tacks on the problems of Coal Preparation and Mechanical Loading was proved conclusively by the intense interest of the operators in both the program and the exposition. Every session was attended regularly, and the discussions were followed carefully. Operators in large numbers represented every coal producing district in the United States. Observers from Canada, England, Belgium and Germany were present. The Pacific Coast, New Mexico, Utah, Wyoming, Montana, and Colorado sent delegations and large numbers of operators attended from the immediately adjacent fields of Illinois, Indiana, Michigan, Kentucky, Ohio, Pennsylvania, West Virginia and Alabama. Delegates needed no urging to attend the sessions. When the opening hour arrived, they were on hand to begin the discussion and they stayed throughout the meeting, after which their interest in the exposition was lively.

The Fourth Annual Convention at Cincinnati was an amazing success. No small amount of credit for that success should be given to the Program Committee and its chairman, Ezra Van Horn, who took such an active interest in developing a program that would meet the present needs of the industry. To the 60 men comprising the committee, to the men who prepared papers, to those companies contributing to the success of the meeting in sending them to Cincinnati to participate, and to the manufacturers who prepared the greatest exhibit of mining equipment ever assembled, the coal industry owes a debt of gratitude. Every paper presented was of outstanding merit, and one which every coal operator will wish to read carefully and file for future reference.

The Exposition was formally opened on Monday evening, May 16th, when the Mayor of Cincinnati, the Honorable Murray Seasongood, welcomed the delegates to his city, and N. L. Mahan, president of the Cincinnati Coal Exchange, extended a cordial greeting from Cincinnati's coal men. H. K. Porter, chairman of the Manufacturers Division of the American Mining Congress, and Ezra Van Horn, chairman of the Program Committee, responded to these greetings, after which an informal reception and dance was held at Music Hall.

No sessions of the convention were held on Monday, although a committee of the American Mining Congress, the Mine Drainage Section, National Standardization Division, held a session which was well attended. The principal discussion at this meeting concerned the contemplated work of Sub-Committee No. 5, dealing with Acid Resisting Metals.

*General view of exhibits along south side of North Hall*

J. A. Malady, mechanical and electrical engineer, Hillman Coal and Coke Co., Pittsburgh, Pa., was elected permanent chairman of this sub-committee in addition to his present duties as permanent chairman of the Mine Drainage Section.

A general session of the Mining and Loading Section, National Standardization Division of the American Mining Congress, was held at a luncheon conference, at the Gibson Hotel, on Wednesday, May 18, just prior to the opening of the sessions of the convention which discussed mechanical mining. G. B. Southward, mechanization engineer for the committee, made a progress report on the work he has been conducting since January, 1927. Mr. Southward stated that in the eastern bituminous coal fields he has visited 35 mines where mechanical operations were employed. Of these, 27 were considered by the managers as being practicable and successful. Anthracite mines in Pennsylvania which have been inspected by Mr. Southward employ successful mechanical operations, but as methods and conditions in the anthracite field are different from those in the bituminous districts, Mr. Southward will later make a report on anthracite. Mr. Southward said that mechanical loaders are being directly substituted for hand loading of coal without changing the mining system. "Mechanical mining consists of a series of coordinate operations. Mine superintendents, foremen, conveyor men, electricians and mechanics have all played an important part in a real job of developing mechanized mining." The work as conducted met with the entire approval of the committee. He was authorized to continue along the same line and to immediately begin the investigation in the territory west of the Mississippi River. Mr. Southward will leave shortly after the first of June for a visit to all properties in the western territory that are using some form of mechanical mining.

A meeting of the Board of Governors of the Manufacturers Division of the American Mining Congress, under whose auspices these conventions and expositions are presented, was held at the Gibson Hotel on Thursday, May 19, when H. K. Porter, Hyatt Roller Bearing Co., was unanimously re-elected chairman of the Division, to serve until the next annual meeting sometime in May, 1928. H. A. Buzby, Keystone Lubricating Co., was re-elected first vice chairman; C. L. Herbster, Hockensmith Wheel and Mine Car Co., second vice chairman; and F. J. Maple, John A. Roebling's Sons Co., third vice chairman. The following directors of the Division were elected: H. K. Porter, Hyatt Roller Bearing Co., Harrison, N. J.; J. C. Wilson, Ohio Brass Co., Mansfield, Ohio; N. S. Greensfelder, Hercules Powder Co., Wilmington, Del.; L. W. Shugg, General Electric Co., Schenectady, N. Y., and H. A. Buzby, Keystone Lubricating Co., Philadelphia, Pa.; Charles Whaley, Myers-Whaley Co., Knoxville, Tenn.; F. J. Maple, John A. Roebling's Sons Co., Trenton, N. J.; C. L. Herbster, Hockensmith Wheel and Mine Car Co., Penn, Pa.; Rex Martin, Link-Belt Co., Chicago, Ill.; J. T. Ryan, Mine Safety Appliances Co., Pittsburgh, Pa.; J. K. Lansdowne, Weir Kilby Corporation, Cincinnati, Ohio; Robert Jeffrey, Jeffrey Manufacturing Co., Columbus, Ohio; P. H. Grunnagle, Westinghouse Electric and Manufacturing Co., E. Pittsburgh., Pa.

The convention proper opened on Tuesday morning, May 17, which began with a series of three sessions devoted exclusively to the discussion of coal preparation problems. The proceedings of these three sessions will be found in full in this issue of the JOURNAL. The three

*General view of exhibits along north side of North Hall*

sessions on coal preparation were presided over by Howard N. Eavenson, of the firm of Howard N. Eavenson & Associates, Consulting Engineers, Pittsburgh, Pa.; Dr. J. J. Rutledge, chief mine engineer, State Bureau of Mines, Baltimore, Md., and J. D. Zook, vice president and general manager, O'Gara Coal Co., Chicago, Ill.

The three sessions on mechanical mining were presided over by Dr. L. E. Young, vice president, Pittsburgh Coal Co., Pittsburgh, Pa.; A. W. Dickinson, general superintendent, Union Pacific Coal Co., Rock Springs, Wyo., and Dr. A. C. Callen, professor of mining, University of Illinois, Urbana, Ill.

W. L. Robison, vice president, Youghiogheny and Ohio Coal Co., Cleveland, Ohio, was chairman of the session on safety, and Erskine Ramsay, consulting engineer, Alabama By-Products Corporation, Birmingham, Ala., presided at the closing session on cutting and blasting.

An informal dinner and dance was held at the Hotel Sinton on Thursday evening, which was a particularly happy affair. J. G. Bradley, a director of the American Mining Congress, and president of the Elk River Coal and Lumber Co., Dundon, W. Va., made a short talk, saying:

"We have come here tonight both to point with pride and to view with alarm, as well as pay tribute. I may say we don't have to come here to pay tribute to the supply industry. I, for one, have been doing it all my life.

*J. G. Bradley*

"I want to welcome Dr. Parker of the anthracite industry, another of our dying industries. I expect they will stick it out as long as I do, and I hope they will. And as far as being in the dumps is concerned, I am one operator who is never in the dumps. Even in the old days out in Clay County, when it was pretty hard scratching and there wasn't such a thing as income in the county, I wasn't in the dumps. A little girl in one of the schools was asked to give a sentence with 'income' in it, and all she could think of was 'In-come-a-rat.' That was during the war. If we can stick to income when it comes to that I think you will have a hard time putting us out of business in Clay County.

"This is a wonderful industry. I might entitle my remarks tonight 'What the South has done for the coal industry,' or I might as well say 'What the industry has done for the South.' Those two are almost synonymous. The contribution of the South to the bituminous industry and to industry in general, in

*Port of the crowd at one of the sessions of the discussions*

the world, is a remarkable and wonderful thing.

"We are now in a state of normalcy in this bituminous industry. We are in the midst of a great strike. Our prices are depressed, but in spite of that we have made wonderful progress, and that progress has been made under southern leadership. This is the progress we have made: We have today 60 percent of the miners and operators and the production in the bituminous industry marching in step, side by side, to get the best out of the industry they can and to give the best they can to make their contribution to the prosperity of the country. When this strike has been fought to its ultimate conclusion, whether it is this year or whether it is two years from now, or whether it will be in six years, eight years or ten years from now, that is the point that the rest of the industry has to come to. We have passed the time when it is possible for an industry to support a union which works for the destruction of the industry from which it gets its living.

"I am heart and soul with the operators in the central competitive field and in those districts which still bow to the union yoke. I wish them every success, but I want to point out to them that if they really expect to be successful they have to take a leaf out of this great book of southern progress and they have to show their men that they are their natural leaders. I don't believe that the standard of American intelligence, the standard of education among the American workmen is so low that they will not respond to that. When they do we will see the bituminous industry the leading industry in the country.

"Most of you don't stop to think what the bituminous industry really is. Some think of it as a group and others think of it as a few hundred thousand miners. In West Virginia alone the bituminous industry has 700,000 people dependent on it for their prosperity and they are heart and soul at work to see that the prosperity of the bituminous industry is continued. In West Virginia we only produce one-fifth of the bituminous coal that is consumed in this country. Multiply that 700,000 by 5 and you have 3,500,000 people in this country who are dependent upon the bituminous industry, whose

*H. K. Porter, Chairman of the Manufacturers Division of The American Mining Congress*

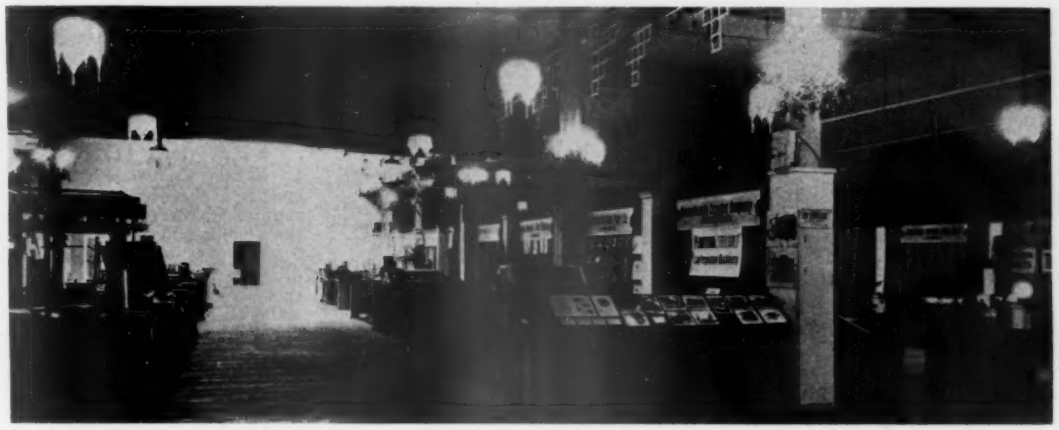
every interest is for the prosperity of the bituminous industry—and the prosperity of the bituminous industry means the prosperity of the country as a whole, because today we are more than ever dependent upon cheap power. We must have cheap power to keep the wheels of industry turning, to keep New England industrially on the map, to build up the cotton mills of the South.

"I don't believe that any industry with 3,500,000 people working for it is going to go far wrong. I don't believe that any industry with 3,500,000 people deeply interested in it ought to be brought under governmental control. I don't believe that it will be if those 3,500,000 people are awakened to the situation. But we have to watch carefully. Organizations like The American Mining Congress have to educate the public as to what this industry is doing for the public, which is far more than the public is doing for it.

"The coal which is being sold today at less than cost of production is giving employment to millions and millions of workers from the Atlantic to the Pacific.

"I said I was hopeful for the industry and I was optimistic about it. I am, but here is one thing to which we should turn our attention. The anthracite industry is today suffering very seriously from the competition of the oil burner and the domestic oil furnace. That is a very simple proposition. We are going to suffer from the use of the oil burner in the domestic furnace next. Our turn hasn't come yet. But it is coming, as sure as fate and we have to enlist the best inventive brains that we have in the country to develop a furnace which is going to enable you to get the ashes out of your back door without losing caste with your neighbors.

"It is a very simple problem but it



*Some of the exhibits in South Hall and entrance to especially constructed assembly hall where discussions were held*

hasn't been solved yet and the cost of burning oil is no answer to it. Was anybody ever stopped from buying an automobile because his neighbor said he couldn't afford it? Was there ever anybody who said he couldn't afford to buy a radio because his neighbor said he couldn't afford it? Will they be stopped from buying an oil burner because the neighbors tell him he can't afford it? No. It is one of the luxuries of modern life to get heat without effort. That is the problem which the bituminous industry is faced with today.

"It is a serious problem. The furnace builders aren't interested in it. They can sell as many furnaces that burn oil as they can furnaces that burn coal. It has to be the coal industry that gets into the fight and solves this problem.

"I said we come not only to view with pride but to view with alarm. Here is one of the things that I view with alarm. Like a good southerner I am opposed to the extension of the powers of the Federal Government. If I needed anything to strengthen me in that belief it would be an address by Dr. George Otis Smith, which I have found. He presides over the Geological Survey.

"Mr. Smith says that the greatest crime that has been committed industrially in America is the opening of the southern coal fields. Gentlemen, that is the pronouncement of the head of the United States Geological Survey. We don't want that sort of thing. We want these bureaus to keep their fingers out of our business.

"Again I congratulate the American Mining Congress on this meeting. I said I paid tribute to the supply business for years, but I would like to pay this further tribute to it. I would like to say that the supply business has unselfishly done our engineering for us. It has done our thinking for us and it has done more to develop the cheap mechanical mining of coal than all the coal operators and all the miners put together. That is what the supply business has done for us. They have done it gladly and they will continue to do it. We can well afford to pay all the tribute they ask us to pay to them."

Noah H. Swayne, Swayne & Co., of Philadelphia, Pa., nationally known coal man and humourist, delighted the large audience with a series of stories. A special Miners Quartet was furnished by the Cincinnati Conservatory of Music, and Mr. McClellen, prominent in business and musical circles of Cincinnati, acted as song leader. H. K. Porter, chairman of the Manufacturers Division, was toastmaster.

*Noah Swayne*

As a whole, this convention was the greatest in the history of the coal producing industry. Never before has there been presented a program of such wide appeal; an exposition of such immediate interest, nor such a large aggregation of coal men to listen to the discussions and to view the exposition.

A great thing for the coal industry is happening through these conventions and expositions—a genuine spirit of cooperation is being developed and the results will be reflected through many years of progress.

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Probably no man in a coal mine is exposed to so much danger during his work as the shot firer. Seven types of single-shot blasting machines have been approved by the United States Bureau of Mines. These should interest every shot firer. Approved machines have safety features that other machines do not have. Magneto machines have been redesigned so that a spark from the machine will not ignite gas. All unapproved machines tested by the bureau were found to be dangerous in this respect. Battery outfits have been provided with covered contacts. Both contacts must be made at the same time by use of a plug. This prevents accidents if the wires unexpectedly touch uncovered or bare battery terminals before the shot firer is ready to fire the shot. A good grade of rubber-insulated wire is required for use with approved machines, and this, too, means greater safety for the shot firer.

# NECESSITY FOR AND RECENT DEVELOPMENTS IN COAL PREPARATION

*Anthracite Preparation In Advance Of Bituminous—Excess Of Impurities Under High Freight Rates Uneconomical—Mechanically Loaded Coal Requires New Methods Of Cleaning—Cleaning And Utilization Of Fines Essential—Problem Is One For Specialists*

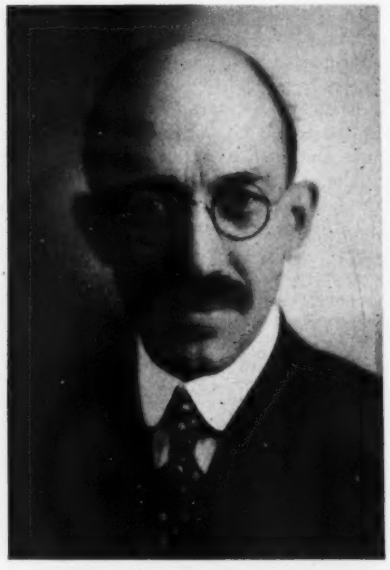
*By* E. A. HOLBROOK *

IN THE past the average bituminous coal consumer has said: "Coal is something black that burns; give me all I want at a low price and I will have no further interest in the product." The average bituminous coal producer has felt that competition so reduced his margin of profit that he had to sell every pound of material that the miner produced. Consequently the consumer has been slow in paying the higher price which is justified by a properly prepared coal, and the bituminous operator in turn has spent as little on coal preparation as the immediate market would permit. Elaborate preparation, therefore, generally has been considered not a regular part of the cost of producing bituminous coal, but as an extra to be added where demanded by market conditions.

With anthracite, the case is different. In this special field the comparatively large percentages of impurities mined with the coal and the education of the consumer to the belief that close sizing is essential, long ago lead to the universal practice of carefully cleaning and sizing practically all of the product mined. Therefore, in the anthracite field, preparation is a regular and accepted part of the cost of producing the coal and there coal preparation has reached its highest state of development. But even with anthracite, perfection in coal preparation by no means has been reached. Some ten years ago the writer went through a new anthracite preparation plant which contained the most modern machinery. Apparently it was a breaker that would be abreast of the art for many years to come. Yet the improved processes and methods of preparing anthracite which have been introduced during the past five years threaten to make this and all older plants uneconomical and obsolete. It is, however, in bituminous coal preparation that the most progress will be made in the next ten years.

On the part of the large bituminous coal consumers, the old plan of buying whatever coal was cheapest received a heavy blow during the war period. The great power plants began to employ trained fuel engineers who know that certain coals prepared in certain ways are cheapest for their companies. The steel plants are employing trained metallurgists, who are carefully figuring what excess ash and sulphur in a coal are costing them. The general realization that high freight rates are with us to stay has caused the more progressive consumers to figure that freight paid on unnecessary high ash is a real loss. Altogether, the buying public in an effort to reduce its fuel bill is using increasing skill in purchasing coal.

The bituminous coal producer who has faced the substitution of hand loaded coal by mechanically loaded coal knows that he must attack his impurities' question in a new way. The producer who tries to enter and compete in a special trade likewise knows that increasingly he must produce a uniform and a clean product, and that some kind of mechanical preparation generally will be necessary. Many of the purer seams are being exhausted, and there are other coals which can take their place, provided the substitute coal is prepared and cleaned. In still other cases it is no longer economical to reject a large percentage of the seam in order to get a high grade coal; all the material on which the expense of mining has been put, should, if possible, be prepared for some kind of a market. Thus we are entering a new era in coal mining, an era when mechanical preparation will be developed and ultimately become a regular part of the cost of producing bituminous coal.



*E. A. Holbrook*

As a matter of history, Europe 50 years ago reached the stage when it was necessary to mine impure seams of bituminous coal; therefore, bituminous coal preparation developed there first. In this country the generally larger quantity of high grade bituminous coals made it unnecessary to go extensively into coal preparation, excepting here and there for a special coal for a special purpose. The first jig coal washer in America was erected in 1869 at Alpsville, Pa., to wash slack for coking, although trough washers were used by Jones and Laughlin in the Pittsburgh district before this time. In Alabama, where the local coal was needed for metallurgical coke, coal washing was developed early. In some markets washed coal was a selling slogan designed to bring for the coal a higher price, and often without regard to the technical effectiveness of the washing process.

In Illinois and the surrounding central district the development of coal preparation took generally the form of careful sizing. By 1912 there were being produced in Illinois some 34 different sizes of bituminous coal. In many cases this close sizing was unnecessary so far as the burning qualities of the coal were concerned, and was carried out because the consumers demanded it. In the eastern bituminous regions where the coal is generally coking, such close sizing has commonly not been attempted, excepting in cases where the coal entered markets to compete as a household fuel with anthracite, and where the close sizing gave the product the appearance of anthracite.

### SIZING COAL

Bituminous coal preparation at the mines means either sizing or cleaning or a combination of the two. Sizing involves the use of screens, of which a great variety have been invented and used. During the past 20 years many elaborate and costly tipple coal screening plants have been erected. Screens fall into four classes as follows:

(1) Bar screens.
(2) Revolving screens.
(3) Shaking screens.
(4) Vibrating screens.

Bar screens are cheap to install and to operate but they do not size accurately. They are ideal where only a rough separation is desired. Revolving screens give well sized products but break the coal badly. Shaking screens, taking little headroom, causing little breakage and having a large capacity, have become almost universal in general coal screening. There are many types of these screens on the market. Vibrating screens are comparatively new in coal preparation, and have an advantage in screening successfully the very small sizes of coal. Screening plants generally contain provision for more or less hand picking of the impurities from the coal.

### MECHANICAL CLEANING

To most people, coal preparation means mechanical cleaning from impurities rather than screening. For many years the story of mechanical coal cleaning was the story of the success or failure of washing the coal by the jig. Most of the first washeries in this country were copies of European washeries, built without great knowledge of the differences between coal here and abroad. Sometimes they worked successfully and sometimes they did not. American resourcefulness tackled the job and soon this or that invention or adoption was tried out. Success came to a few, failure came to many. As a result of this experimentation, today the operator about to clean his coal mechanically has the choice of a considerable number of meritorious processes, each one of which may be the best for a particular coal or a

* Dean, School of Mines, State College, Pa.

*Howard N. Eavenson who presided at the first session of the discussions, devoted to Coal Preparation*

*Dr. J. J. Rutledge, chairman of the second session of the discussions also devoted to Coal Preparation. The third session was presided over by Mr. J. D. Zook whose photograph was unavailable*

*Dr. L. E. Young, who occupied the chair in the fourth session of the discussions, devoted to Mechanical Loading of Coal*

*W. L. Robison, chairman of the seventh session, devoted to Safety In Coal Production*

*Ezra Van Horn, chairman of the Program Committee*

*A. W. Dickinson, who presided over the fifth session, also devoted to Mechanical Loading*

*Erskine Ramsay, who presided over the eighth and last session when Cutting and Blasting were the topics discussed*

*A. C. Callen, who presided at the sixth session, the last session devoted to Mechanical Loading*

CHAIRMEN OF VARIOUS SESSIONS OF THE CONVENTION

special condition. The operator must recognize that every coal offers a distinct cleaning problem of its own, and a plant that will clean one coal satisfactorily is not necessarily the best for every coal and condition.

In order that the various coal cleaning processes may be understood more clearly, the writer divides them into five separate classes as follows:

(1) Friction.
(2) Water or hydro gravity separation.
(3) Air or pneumatic gravity separation.
(4) Float and sink.
(5) Non gravity.

(1) The friction process is illustrated by the Pardee Spiral Dry Separator, which was invented and used in the anthracite district and which has found some application in the bituminous field. Its principle is the simple fact that coal will slide down an inclined metal chute faster than slate or other similar impurities. It requires dry, sized coal.

(2) The water or hydro gravity separation processes have long been the most common, and include the trough washers, piston jigs, pan jigs, concentration tables, stratification current washers (Rheolaveur), and rising current and decantation separators (Hydrotator). The last three processes have made great headway during the past five years.

(3) The air or pneumatic gravity separation processes use either air jigs or air tables. Their development has been rapid during the past few years, especially for treating the small sizes of coal.

(4) Float and sink washers are the wet sand flotation (Chance Process) and the dry sand flotation process, and small laboratory washers using chemicals as the liquid medium to accomplish the separation. Sand flotation is a successful development since the war period.

(5) Under non gravity processes are included the froth flotation process now being tried on English coals, the oil amalgam (Trent) process and the electrostatic process.

Many of these devices will be described in greater detail at this session.

The operator should realize that the selection of a particular process depends, not exactly on what it has done with some other coal, but what it will do with coal of the same nature and character as his own. David White, of the United States Geological Survey, once said: "Coal is like character, the deeper you get into it, the more interesting it becomes." You want to realize that the washability of your coal depends collectively on the physical structure of the coal substance, the physical forms of the impurities, the specific gravity of the component parts that make up the seam, and the chemical nature of the sulphur. With these four points accurately determined, progress toward the selection of a proper cleaning device can be made.

### Washability of American Coals

Fraser and Yancey, in an unpublished Manuscript on coal washings, have shown clearly how the different seams of coal differ in their washability by classifying the American bituminous coal seams as follows:

*Class I.* A clean seam of coal which becomes mixed with roof and floor rock impurities during mining. This class of coal is most easily cleaned. It contains only clean pieces of either coal or rock and has no middling or secondary coal (pieces part coal and part impurity).

*Class II.* A seam of coal with the impurities concentrated in definite thick partings of shale, pyrite (sulphur) or both. These definite partings break free from the coal in mining or by crushing to a moderate size. Compared with Class I, this coal may have a small quantity of middlings.

*Class III.* A seam of coal with the impurities concentrated in very thin definite binders and partings of shale, pyrite or both. A large proportion of American coals needing washing are of this class. The thin interbedded streaks of earthy mineral matter make up the ash impurities. They are classed as binders if they do not break free from the coal or as partings where they do break free.

*Class IV.* A seam of coal with impurities of bone (coal with 40-60 percent coal material) or carbonaceous shale (black shale with 0 to 40 percent coal material) segregated in definite bands or benches. The thick bands or benches of bone are usually at the top or bottom of an otherwise clean seam, but occasionally they are interbedded with the seam. Often they are but little different in specific gravity from the rest of the seam, and thus in washing produce large amounts of middlings or secondary coal.

*Class V.* A seam of coal with alternating bands of coal, bone and shale, or with many interstratified layers of bony coal. Coal of this character is the most difficult to benefit by washing.

*Class VI.* A seam of bony coal in which the bone predominates over the coal in quantity. Seams of this character are of little value in their original state and have not been worked in this country excepting locally. Abroad they are being mined to some extent and the good coal recovered by careful treatment.

*Class VII.* A coal seam high in sulphur. This sulphur may be largely in the form of pyrite or mostly in the form of organic sulphur. The use of this coal for a particular purpose depends entirely on the ability to remove sulphur.

By all means an operator considering cleaning his coal should place his coal in one of these classes, and should know that his washing or cleaning problem is different from that of a man having a coal in one of the other classes, and irrespective of the cleaning machinery used.

### Cleaning Fines

A final problem universal with coal cleaning is the treatment and disposal of fines or the small sizes of coal. Where we used to think of ½-in. coal as small coal, tomorrow we may be calling this large coal and thinking in terms of pulverized coal 100 mesh (100 mesh to the inch) and finer. In most cases, the finer we crush a coal before treatment, the greater is the elimination of impurities, because they are broken free from the coal. The present difficulties of ridding such fine coal of water are well known. Already in England they are treating commercially fine coal by froth flotation, and in this country the so-called Trent process forms an amalgam of oil and finely pulverized, nearly ash-free coal. I foresee a future race between the fuel engineer intent on getting the maximum heat value out of the fuel and constantly using finer sizes, and the coal preparation engineer, who will have to meet the demand for clean coal in these fine sizes and in a condition suitable for best combustion.

### General Conditions

Finally, coal preparation has much in common with ore dressing, or the removal of impurities from minerals and reducing them to a purer form. A century ago minerals were pure enough to be used as mined, with little preliminary treatment. Need for utilization of lower grade deposits lead to the introduction of more complicated processes and plants for treatment. Today practically every ore mine has a preparation plant. Because of the high value of the ores much experimentation and complicated plants were justified. This work has become so specialized that we have today ore dressing specialists or engineers not only to design but to superintend and to operate plants.

Coal preparation plants are today taking over and adopting many of the processes and machinery first used in ore dressing. The time has come to realize that if the coal industry is to make a success of the intricate problems of coal preparation, it must be prepared to put the work in charge of specialists who are not mining men and not chemists, but coal preparation engineers.

At this meeting we are to realize what a high order of inventive genius and engineering skill has been brought to bear on the coal cleaning problem, how we have taken and adapted the best that European experience had to offer, how we have searched the ore and metal preparation industries for the devices in use there, and how we have, when these did not suffice, developed within the coal industry itself the processes necessary for the particular condition and coal.

Coal preparation has come to the coal industry to stay, and no matter how unwelcome a stepchild it may be, I want to assure its exponents that we welcome them and appreciate this opportunity to become informed on these latest and most effective methods of producing cleaner coal.

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### 1926 ANTHRACITE TONNAGES

The Glen Alden Coal Company, Scranton, Pa., took first place in 1926 as the country's largest anthracite producer, raising 9,922,716 gross tons, compared with 9,709,757 by Philadelphia and Reading Coal & Iron Company, which is usually known as the largest hard coal mining company. Its production gained 2,625,000 gross tons, or 36 percent over 1925. Reading Coal's production gained 1,787,000 gross tons, or 24 percent. Another large gain for the year was scored by Hudson Coal Company, subsidiary of the Delaware and Hudson Company, whose 1926 gross tonnage of 9,165,802 was 2,272,000, or 33 percent, over 1925. Largest proportionate gain was scored by Lehigh & Wilkes-Barre Coal Co., which was 40 percent. Lehigh Valley Coal Company's tonnage gained 30 percent over 1925. Hudson Coal Company was the only one of the group to show larger tonnage last year than in 1923, and Lehigh & Wilkes-Barre the only one to exceed its 1924 tonnage.

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The Hazle Brook Coal Company is opening a number of new strippings at Maryd, near Tamaqua, Pa., and contractors are assembling a big battery of steam shovels for the excavating work.

# EFFECTS OF COAL CLEANING ON ITS MARKETABILITY

***While There Are Available No Data For Comparative Purposes Coal Preparation Is A Decidedly Important Factor And Makes Possible The Sale Of Coal To A Specification—That Cleaning Coal Can Be Made A Success Commercially And Financially Is Being Demonstrated***

*By* F. R. WADLEIGH*

AS far as my knowledge of publications and papers on coal goes, this is the first occasion on which this subject has been proposed as a definite topic for treatment.

In fact, literature on the cleaning of coal has been exceedingly meagre; I believe that only one book devoted to the general subject has been published, rather remarkable when the importance of the matter is considered.

There are no available statistical data as to the effect of coal cleaning on its marketability and it is, therefore, a subject that does not readily lend itself to the treatment in terms of actual statistics, or of dollars and cents, and is a difficult one to illumine by facts as to quantities or financial returns.

### THE PREPARATION OF COAL—ITS IMPORTANCE TO THE USER

The preparation of coal—its cleaning or the removal of extraneous impurities and its sizing—is, whether he realizes it or not, a decidedly important matter to the user of coal, whether for heating his house and office or for making steam, in metallurgical furnaces, in coke ovens, or in gas retorts or producers.

Preparation begins at the "face," in the mine—it reaches all the way and is felt at every step along the way, from the "face" to the ash dump; it is an important element in transportation—it affects the burning of coal and its distillation, together with the results obtained in each.

Finally, it bears directly on domestic heating costs, on the production costs of the industrial user and the public utility, as well as on railroad operating costs.

### BRITISH COMMISSION ON COAL PREPARATION

The 1925 British Commission on the Coal Industry in the general statement contained in its report makes some pertinent remarks regarding preparation of coal in Great Britain which apply to conditions in the United States as well. "The preparation of coal for the market is becoming of increasing importance. The higher price of coal now ruling makes the purchaser more particular as to the quality supplied, and this is especially the case in foreign markets. Connected with this is the question of buying coal under a guarantee as to quality, or at a price depending on some ascertainable characteristic, such as ash content or calorific value. A uniform quality may be important to the consumer, and he may prefer a coal on the characteristics of which he can depend to a coal of possibly higher but varying quality.

"The methods to be adopted in grading and cleaning coal must necessarily depend upon the circumstances of each pit, and the purpose for which the coal is to be used. We consider that increased attention should be paid to these points by the industry, and that the study of methods of cleaning, grading, sizing and blending coal is one of the most important of the duties which should be undertaken by the organizations for research to which we refer in a preceding chapter.

"More careful preparation makes possible the sale of coal to a specification, and this should have a beneficial effect upon the export trade, and, indeed, upon the coal trade generally, assuming that the specifications are reasonable and confined to essential points. Any rigid specification of nonessentials can not be beneficial, and may be harmful.

"We feel that it would be of considerable benefit in many cases if the producers and dealers in coal were to state the broad specifications for the coal which they were prepared to supply. Were this practice generally adopted it would ultimately lead to the special value of individual seams for particular purposes being adequately realized."

It is possible to make certain definite statements concerning the cleaning of coal and its value. The definition of dirt as matter out of place is never more appropriate than when applied to the incombustible content, the "extraneous" mineral matter, of coal.

The object of cleaning coal is to increase the proportion of the useful to the useless matter contained in it. Clean coal is of greater commercial and industrial value than dirtier coal and should, therefore, command higher returns, either in price per ton or in greater volume of sales and permanent business—in greater marketability.

The difference in value between a clean coal and a dirty coal is generally, but not invariably, greater than the cost of efficient cleaning.

The futility and wastefulness involved in transporting ash is, of course, obvious. Regardless of the use to which coal may be put, it requires transporting and handling, the two latter often costing more than the actual mining.

The fact that the efficient cleaning of coal can be made a success commercially and financially is being demonstrated daily, as can be readily proved.

The slogan "safety first, then clean coal," is the effective answer of one of our largest coal producing and selling companies to the question indirectly asked in the title of this paper. But one of the greatest difficulties in the way of obtaining better returns from coal-cleaning preparation is the lack of interest and knowledge, on the part of the consumer, of its value and importance to him, with his unwillingness to pay more for cleaner coal, even when he does realize its added value in use.

It is proper to emphasize here the importance that coal preparation, especially that part of it which involves cleaning, has to the user, industrial or domestic. It is in fact, and should be so known, one of the most important elements in his fuel problem. There is no item involved in coal purchase, supply, and use that is and should be of more interest to those having charge of coal purchase and use as well as to those engaged in the design and operation of plants using coal as fuel.

The effect of coal preparation is felt in every step of handling and use, from the mine to the ash dump. The cost of transportation, of plant operation, cost of the product, whether heat, electricity, iron and steel, bread and ice cream, transportation or motor cars—coal-cleaning preparation affects each, to a greater or less degree, as well as the heating of homes and offices.

Why, therefore, should not the consumer be willing to pay for efficient cleaning of his coal? One reason for his not doing so is, to a considerable extent, the fault of the seller. The latter does not always impress upon the buyer the importance of preparation and the better results obtained from clean coal. In fact, many of our coal salesmen do not know its importance, nor the methods used to produce the cleanest possible coal. It would seem highly advisable for everyone whose business is to sell coal to be thoroughly informed on the subject.

It is reasonable to suppose that, given exact knowledge on the part of the salesman as to the preparation of his coal and the better results to be obtained, as measured by better cleaning, consumers might be brought to a clear understanding of its added value as compared with coal not properly cleaned, and would be willing to pay for cleaner coal, either by higher prices or in some other way, such as additional tonnage or permanent business.

Are there not many coal salesmen who can talk glibly about B. t. u.'s and ash content but do not know how their coals are mined and prepared or what both mining and preparation have to do with both ash content and heating value?

It is our belief that every coal salesman, whether wholesaler or retailer, should be given a preliminary course of training in coal preparation methods and the effect of coal preparation on the results obtained in actual use of the coal. A few weeks' stay at the mines, studying the mining and preparation of the coals he has to sell, should be required of every salesman and sales company official, as well as regular visits at specified intervals afterwards.

In fact, one important angle of coal-cleaning preparation, especially as regards its possible value to the producer, is the matter of getting the consumer to realize its importance and value.

Apart from the ethics of the subject, the incentive of the producer to clean his coal lies mainly in the possibility of obtaining some definite financial returns on his expenditure. And to do this he must take effective steps to force the buyer of his product to realize the increased value of clean coal and compensation in some form.

A comparison of coal company advertisements as put out today with those of 10 years ago shows unmistakably that many coal sales companies understand the importance of setting forth to the consumer the value of clean coal, the greater degree of general interest in preparation and the added number of new devices for cleaning are further definite indications pointing in the same direction. (*Continued on page* 403.)

* Consulting Mining Engineer, New York City.

# ECONOMICAL METHODS OF ELIMINATING IMPURITIES IN THE PREPARATION OF ANTHRACITE COAL

*Inherent And Foreign Impurities Discussed — Uniform Product Essential—Evolution Of Coal Cleaning Processes Defined—Requirements Of Present Day Anthracite Market—Rise In Cost of Production Inevitable*

By F. G. WILCOX *

THE necessity of economical methods for preparing coal depends upon two things, viz: (1) The character of the seam, and (2) the method and care exercised in mining it.

The object of economical preparation of coal is the removal of impurities without degredation of sizes.

Ash in domestic and industrial anthracite coal reduces the B. T. U.'s in a given quantity of coal and absorbs a portion of the heat furnished by clean coal. It reduces boiler capacity by taking up space on the grate bars which should be given to good coal. The presence of pyrites and other ash producing substances in the fuel produces clinkering. These tend to increase expense in freight and ash disposal, reduce boiler efficiency and are detrimental to boiler operation.

There are two general kinds of impurities in coal: Inherent or inseparable impurities are a part of the organic matter of the original composition forming the coal, and foreign impurities which were deposited simultaneously with the organic matter or during intermediate periods. Inherent impurities may consist either of ash or sulphur, or both combined, and are not removable by commercial preparation. Foreign impurities consist of sulphur and other ash producing substances, the former usually in the form of pyrites and the latter as rock, shale, slate and bone.

In any locality the coal of any particular seam may be practically free of foreign impurities and of excellent quality, or, it may have a well defined layer of impurities running through it, which by careful mining will produce a coal in which no preparation is necessary. However, the majority of seams in the region carry such impurities as can be removed only by some mechanical means of preparation.

In the early mining, only the thickest and richest seams were mined. These virgin seams are becoming depleted, and seams are now being mined which are thin and impregnated with impurities. Coal is now being mined from caved areas, mechanical coal loading equipment is coming into use, coal from culm banks is being reclaimed and, due to these causes, a higher percentage of impurities finds its way into the product, demanding an economical preparation.

To overcome the difficulty of preparing coal mined under these conditions, coal companies have spent vast sums of money on many processes in order to obtain a uniform product, with minimum ash, at a minimum cost.

Among the economical methods of eliminating impurities used in the anthracite field in the order of their development are the following: Emery slate picker, Pardee spiral separator, coal jigging machines—such as Lehigh Valley, Christ, Wilmot, Elmore, James, Ransom, Riley-Knapp; concentrators, such as Diester and Plat-O, the Dorr method, the hydro separator by Menzies, the Chance sand flotation method, the hydrotator method, and the rheolaveur method.

The economical preparation of coal is one of the most vital problems facing the industry today, and as time goes on, it will become more so. The consumers of domestic and industrial anthracite coal demand a better prepared coal from year to year. Preparation several years ago was nothing compared to what it is today. The change has been gradual from a higher to a lower impurity limit.

The problem as it is today is not only one of the removal of impurities, but also one of sizing in order to give it the proper appearance. Domestic and industrial anthracite coal must fulfill the following requirements:

1. Domestic anthracite must be a high class household fuel as free as possible from ash and properly sized so as to present a uniform appearance, and be free from clinkering.
2. Industrial anthracite must be a high class steam coal, low in sulphur and ash, and uniform in size with a minimum amount of undersize.

Inasmuch as the economical production of any commodity depends upon the continuous operation of the plant in which it is produced, it therefore follows that economical methods of preparation which will give the most satisfying results must be obtained in order to get an economical and dependable fuel.

To accomplish this purpose, we believe the method used should fulfill the following requirements:

1. The prepared coal should contain a minimum of ash or impurities, and the refuse should contain a minimum of coal.
2. It should have a large capacity, with a wide range of sizes which it can prepare, in which there should be a minimum amount of degredation.
3. The installation cost should be a minimum, the maintenance cost low and the operating cost a minimum.
4. It should be flexible and simple in plan and operation.
5. It should be able to prepare both fresh mined and culm bank coal simultaneously.
6. It must yield a product dependable daily.

The mechanical requirements of the method should be as follows:

It should be of sturdy construction, have a small number of moving parts, which are easily accessible, with simple lubrication.

It should have a low consumption of separating medium, whatever may be used, and it should have a low power consumption.

In order to arrive at the most economical method of eliminating the impurities in any particular coal, we believe it is first necessary to investigate the physical properties of the coal to be prepared, and of the impurities to be eliminated.

These physical characteristics depend upon the size, fracture and specific gravity of the coal, and the same can be said of the impurities. It is important to determine also if there is a wide difference in specific gravity in coal from different seams feeding into the plant. It should also be ascertained what separating medium is to be used. Washability curves should be made of the different sizes to determine the maximum economical recovery point, and when you have established what can be done with your product to give the best results, it is then desirable to install the preparation method which will best suit your particular needs.

Economical methods do not necessarily mean the installing of expensive machinery and equipment—on the contrary it may not mean the installing of any machinery other than crushing and sizing equipment. It depends entirely upon the amount of impurities in the seam or seams to be worked.

On the other hand it may mean the installing of expensive machinery and equipment when a high percentage of impurities finds its way into the product, and gravity or flotation methods have to be employed.

We all know that the first advance in preparation was practiced at the face in the mine and on picking tables in the breaker. This method, helpful as it was at the time, was only good when the thickest and richest seams were worked.

In the earliest methods in which mechanical means of preparation were employed such as the Emery picker and the Pardee spiral separator, dependence was placed upon the relative drag of the coal and impurities over the surface of the device, the principle being that the impurities due to their greater friction would move more slowly than the coal in their descent through the machine by gravity.

In the advanced methods such as the various jigs, hydro-separator, hydrotator, Dorr and Rheolaveur, these make use of the stratification of the feed composed of a mixture of coal, impurities and water in agitation, in which the impurities are removed from the bottom of the bed of material and the coal from the top.

In the concentrator or table method they also make use of the stratification of the feed composed of a mixture of coal, impurities and water in agitation, and by means of riffles into which the impurities settle, the reciprocating movement advancing the impurities along the riffles to the end of the table while the coal which is lighter flows over the riffles with the water.

The Chance method makes use of flotation by introducing sand or other heavy material in water to produce a sufficiently heavy mixture so as to float the coal and not the high ash impurities. The coal in this method is floated out of the machine and the impurities are trapped out at the bottom.

The coal consuming public is demand-

* President, West End Coal Co., Scranton, Pa.

ing a higher quality of domestic and industrial anthracite coal at cheaper prices from year to year.

The quality of the mined product and mining conditions are constantly changing. The steady rise in cost of production, together with high freight rates, taxes, and royalty charges, the large sums of money necessarily spent in advertising, to create a demand for the product, and to keep our old customers from becoming a competitor's new customer, makes it necessary to use the most economical methods of mechanical preparation to give more nearly full time operation, greater efficiency, eliminate waste and reduce cost of production to the industry.

Following the presentation of Mr. Wilcox's paper, ***MR. LEVER C. ASHMEAD**, Consulting Engineer, Wilkes-Barre, Pa.*, lead the discussion, saying:

"I have listened with a great deal of interest to the paper that has been read by Mr. Wilcox and agree with him as far as it goes, but he has left out one phase of the situation, which is becoming of considerable importance in the mining and preparation of anthracite.

"That is, the lessors of the various properties become less satisfied as the years pass in the tons of coal recovered per foot acre and are urging the coal companies to increase this production for it means to the lessor greater return on his money. This brings us to the question as to the place to clean coal.

"If we take our first cleaning step in the mine we then try to remove from the coal as much refuse as possible so that our car yield may become greater, but in doing so, it is difficult to remove only pure rock and then also it is left to the judgment of the miner as to what he is to discard and very often good coal which may be attached to bone and rock is thrown away in the gob, becoming a total loss and reducing the amount of coal produced per foot acre and involving the operator in difficulties with the lessor. It seems to me that the proper place to prepare coal is not underground where the human element enters entirely into the preparation, but it should be, I believe largely done on the surface, in the breaker or tipple where it can be done mechanically giving us the greatest possible recovery and, of course reduce the losses to a minimum.

"In some places in the anthracite region this is done, and the rock and refuse which would ordinarily be left in the mine is either sent to rock banks or returned to the mine for rock packing, or ground up and sent back as silt and used as roof support.

"In certain parts of the anthracite region, particularly where the measures pitch steeply it is impossible to make any underground separation and all of the preparation is done on the surface. If this idea were more generally adopted in the flatter measures it would permit the introduction of loading machinery which would increase the output per man employed, and therefore, counter-balance to a very large extent the money that might be lost due to the loading of all refuse and transporting it to the surface with the coal and then preparing it.

"Of course, each individual operation requires a careful study in order to determine which is the most economical method to use, and we must consider first, that a preliminary separation in the mines by the miner involves the use of inefficient labor in making the separation, and second, whether or not it is more economical to load all the coal and refuse in the mine cars, transport it to the breaker or tipple and prepare it mechanically and dispose of the refuse either on rock banks or by returning it to the mine for roof support. With these two factors has to be considered the extra cost of transportation due to the handling of the refuse mixed with the coal as no separation is made underground and, second, the possible introduction of mechanical loading devices which will increase the output per man."

## EFFECTS OF COAL CLEANING ON ITS MARKETABILITY

(*Continued from page* 401)

There is still another phase of coal-cleaning preparation that is, perhaps, not generally taken into consideration, namely, the question of preparing coal to suit the requirements of different uses. The lowest ash coal is not always the one best suited for certain uses; for instance, coal of a low ash content will sometimes yield a much greater percentage of unburned coal than one in which the percentage of ash is higher.

There are processes in which the use of the purest coal is not essential and, therefore, not economical. A study of this angle of coal use might be of value to the producer as one possible way of adding to the market value of his coal-cleaning preparation.

One of the most important factors in the economical and efficient use of coal is uniformity of quality and character.

To the producer uniformity in the quality of his product should be a really fundamental consideration in the cleaning of coal for the market. What the consumer wants is not only a well-prepared clean coal but one that is uniformly so; a point not always brought out in coal marketing and in coal advertisements.

"A coal of unvarying (within possible limits) quality and character is what the consumer wants — modern preparation and cleaning methods, if efficiently handled, will go far towards giving him such a coal and will often overcome, in sales competition, the handicap of lower heating value, thus adding to the 'marketability' and increased sales."

Two general instances of the value of coal-cleaning preparation in use and marketability are worthy of mention. Unfortunately, the railroads are not always willing to pay more for clean coal, but they do usually give preference to the producer of the cleanest coal among those offered.

Our steam railroads use from 25 to 28 percent of the annual production of bituminous coal. The remarkable results that they have brought about recently in the more economical use of coal is undoubtedly due, to some extent, to the establishment of fuel-inspection departments by all of the larger roads, whose inspectors not only examine the coal as received but also often visit the mines from which the coal comes, for inspection of preparation methods and efficiency.

The effect of coal cleaning on its marketability is also shown by the success of Great Britain in establishing foreign markets for its coals. There can be no question that the care given to preparation of the British coals, more especially before the war, has had a great deal to do with their securing and retaining foreign coal trade. On the other hand, it is equally true that much foreign coal business had been lost to United States shippers for the reason that, while our coal was just as good and in some respects superior to competing coals, it was not given proper cleaning preparation.

The subject of this address leads to some mention of a method of coal purchasing that still obtains in some quarters, its more extensive use having been practically stopped by war conditions. I refer to the method of purchasing coal on specifications. This method of buying really involves a recognition of the value of preparation and clean coal on a definite money value basis. The great objection to the use of this method and perhaps the reason why its use was not more extended was the difficulty in sampling the coal purchased. Although we have standard methods of sampling all kinds of coal deliveries, their use involves considerable trouble and intelligent handling. There are other difficulties in the use of this method of purchase, such as determining the proper standard for the coal, agreement on an equitable basis of payment, etc. This is not the place, however, to discuss the advantages and disadvantages of this purchase method, but the fact that it did give a considerable measure of recognition to the value of cleaning coal justifies its mention.

### Research

Much more research is needed in the question of coal ash—the mineral matter, the impurities that are mined with the coal, and their removal in preparation. A study of this subject should include the effects and value of coal-cleaning preparation in coal distribution and use.

It is a rather complicated subject, involving, as it does, chemistry, physics, mechanics, economics, and transportation; additional knowledge regarding it on the part of both producers and users will undoubtedly be to the economic advantage of each.

In this connection it is of interest to note that the American Society of Mechanical Engineers has under consideration a recommendation by its fuel-survey committee that the society inaugurate and sponsor its own active coal-preparation research work.

"*Elimination of Waste is a Total Asset. It has no Liabilities.*"—HERBERT HOOVER.

Cleaning of coal, freeing it from waste material of no value, is, in the coal industry, one effective method of waste elimination; it should be an asset to the mine operator if he chooses to make it so—to see that his coal is properly cleaned—to make the consumer see it also and be willing to pay for it.

The individual consumer, every consuming industry, wants clean coal; it is up to the coal operators and their sales agencies to obtain a fair compensation for it—in an increased price per ton, in heavier purchases, in permanent business, in satisfied customers.

May I be permitted, in conclusion, to refer to what may be rightly termed the ethics of coal preparation? Preparation of coal is true service—serving by making the best possible product. "The better we serve, the more we earn." No real service has ever been, or ever will be, wasted.

The real purpose of all business is service to customers and to owners; the proper cleaning of coal is service to all who handle it; to the producer by making his product easier to sell, to the railroad by requiring less transportation service, to the consumer in its more efficient use.

# ECONOMICAL METHODS OF ELIMINATING IMPURITIES IN THE PREPARATION OF BITUMINOUS COALS

*Fluctuations In Market Price Must Be Considered—Problem Becomes More Acute As Size of Product Decreases — Increased Selling Price Must Balance Decreased Production — Quantity Purification An Advantage*

By HUMPHREY D. SMITH *

IN discussing the economic methods of eliminating impurities in the preparation of bituminous coals, there are many factors that enter into such a discussion from an economic standpoint, due to the wide difference in coals from various fields, in the type of impurities present in the seam being worked, and mainly to the market in which the coal is to be consumed and the price received.

In general the word impurity as used in the coal trade, covers two main types of impurities: First, free impurities, such as stone, slate, shales and other foreign materials having no fuel value, and which usually have a specific gravity of above 1.75, and an ash content above 70 percent. Second, impurities classed as bone, sulphur, rash, etc., which have little fuel value as their ash becomes high with a specific gravity from 1.50 to 1.75 and an ash content from 30 to 70 percent, and then the lighter bones or high ash coals with a specific gravity running from 1.35 to 1.65 with an ash content from 8 to 30 percent and have at times considerable fuel value.

The gravities differ in the many seams, but the above is a general classification which will cover the large majority of bituminous coals.

There are very few coals being produced from which the free high ash impurities can not be removed, but whether they can be economically removed depends on three main points:

(1) The market price which can be obtained for the coal before cleaning and after cleaning.

(2) The price for which the coal can be produced and loaded in the railroad car before cleaning and after cleaning.

(3) The cost of cleaning, or removal of impurities.

The market price which can be obtained for the coal varies on the different grades or types of coals, with reference to the analysis of the coal, usually classified as low volatile or smokeless, medium volatile, and high volatile, also considering the ash content, the fusibility of the ash, sulphur and other characteristics, which make it especially adaptable for certain uses by consumers.

The prices also vary on the different sizes of coals, namely, lump, egg, stove, nut, pea, and slack, and the combination of all run-of-mine, which sizes go to different types of consumers.

The lump, egg, stove, nut and pea sizes usually go to the domestic trade, slack to the by-product ovens and steam users, and run-of-mine to all classes of consumers.

From the domestic consumer's standpoint, the larger sizes of coals should be well prepared and free of impurities down to a certain point. For example, if he were buying a coal put in his cellar, 7 percent in ash, he would not want to pay any more for the same coal if it ran 6 percent in ash or 5 percent or less, for the last 1, 2, or 3 percent reduction in ash would mean so little to him in the amount of ashes carried out of his cellar, that he could not see the benefit of paying from 5 cents to say 50 cents per ton extra for the difference in a ton of 7 percent and a 5 percent ash coal.

This viewpoint changes considerably when it comes to a by-product oven consumer, gas producer, steam and other consumers, who should be able to pay for clean coal a price that would allow the producer to properly clean and prepare his coal.

Unfortunately from a cleaning and preparation standpoint, the market prices which the producer can obtain for his coal f. o. b. mines changes so rapidly and often, that it is hard for him to figure to what extent of cleaning he can go in removing the impurities to insure him at least an equal return or greater after cleaning, than he would obtain if he had not cleaned at all or only to a small extent.

Impurities are of different composition as previously mentioned and also occur in the different sizes of coal.

The simplest and most easy size to clean is the lump size coal, which can be hand-picked by the miner at the working face or by hand pickers on a picking table in a modern tipple, and in some cases where there is very little refuse, and the tonnage small, in the railroad car during the loading of same.

The egg size coal running in size from 6-in. maximum to 2-in. minimum and varying between these two, can in some cases be hand-picked at the working face, on picking tables in the tipple, hand-picked in railroad cars where the capacity is small and also a small amount of impurity. There are some seams of bituminous coals in which the egg size runs very high in free impurities, which consist of slates and high and low ash bones. Large capacity plants where the number of pickers necessary to clean this size well would make the cost of hand-picking prohibitive, have found that it was necessary to mechanically clean at least part or all of this size. In other cases where a tipple has been built and with picking tables for this size installed, it has been found that the impurities in this size have increased to a point where to properly pick it is necessary to cut down the feed of coal per hour to the tipple, so the egg size could be picked satisfactorily for market, which slowing up of the feed, reacted back in the mines, decreasing the output per day, increasing costs to a point where it was economically necessary to mechanically clean this size, although the cost of mechanically cleaning may be more than hand-picking, but the increased production which may result may overbalance the increased cost if apparent.

It has also been found in some cases that the cost of hand-picking coal running heavy in impurities was more than the cost of mechanically cleaning on the egg size. Some of the wet processes have cleaned egg coal up to 5-in. in size, and also treated this size in combination with the stove and nut sizes and also with sizes down to slack. Some experiments have been made in treating egg size on the dry concentrating tables and have met with some success.

The stove, nut and pea sizes are all being cleaned by both the wet and dry processes, and in some cases where the amount of free impurities is small and tonnage small, hand-picking has helped considerably, but when the amount of impurities is large in these sizes, some form of mechanically cleaning the coal is necessary and economical. The pea size can only be mechanically cleaned for it is practically impossible to hand-pick this size.

The slack size coal, if cleaning is necessary, can only be cleaned mechanically.

Of the above mentioned sizes there is only one way to clean the lump and that is by hand-picking; one way for the pea and slack and that is by mechanically cleaning; and the egg, stove and nut by both methods. The most economical method for these can only be determined by a study of the particular coal with its impurity, also the quantity of these sizes to be cleaned.

In some coals the stove and nut sizes run such a small percentage of the total coal, that if the tonnage produced is small, it would not be economical to put in a cleaning plant, for the investment and operating cost might be too large for the tonnage to be treated and hand-picking on tables would be more economical. In general where these sizes run a tonnage in the plant of 20 tons per hour or more, and where the impurities are of such an amount to make this size unmarketable without cleaning, there is some type of cleaning plant that would be economical to fit the peculiar condition.

Where the pea and slack or part of the slack must be cleaned there are two main methods which have been proven economical, mainly the so-called wet washing process and the dry cleaning, which are being used to clean the stove, nut, pea, and slack sizes.

Among the wet processes are the Rheolaveur, Chance, Sand Flotation, The Robinson Tub, various types of jigs, the Hydrotator, the Menzies Hydro-Separator and other wet processes. The dry cleaning processes as used constitute the pneumatic concentrating tables, namely, the American and Arms tables.

In this discussion no attempt will be made to go into the details of the different processes for mechanically cleaning, as separate papers will cover some of these and the manufacturers will gladly give this information to anyone interested.

In trying to determine which process, the wet or the dry, would be most economical for a particular plant or coal, it would be necessary to know to which type of consumer the coal was most particularly adapted, whether they required

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a dry coal, or if they could use a wet coal, and if they could use either, how much more would they pay for a dry coal than a wet coal. If this could be determined, it would be possible to figure out the most economical process for cleaning, either dry cleaning or wet washing and drying after washing.

After this question was determined the next point you would need to know would be the quantity of coal to be treated, and the sizes that would have to be treated in the particular plant. These features would help determine the size of the plant required.

The next point would be the type and quantity of the refuse or impurity that was desired to be removed, which would also have a bearing on the type of plant necessary to perform the cleaning operation most economically.

The cost of cleaning is made up of four main items:

Power, labor, maintenance and overhead, which includes depreciation and investment costs.

There is another cost item which is an indirect cost resulting from cleaning coal, and that is the loss in rejects or waste material which is taken out in the cleaning plant which the mine normally shipped previous to cleaning. As an example a mine may be running a tonnage per day of 2,000 net tons, with a total mining cost of $1.75 per net ton in the railroad car. Should that mine put in a cleaning plant and remove 10 percent by weight of material in the way of refuse that it brings out of the mine in the mine cars, the cost of the coal cleaned in the railroad car would be $1.95 per net ton, and only 1,800 net tons would be shipped, not including the cleaning cost. Thus if the cleaning cost, power, labor and overhead was for example 20 cents per net ton, this added to the rejection cost or difference of $1.95 and $1.75 or 20 cents would give a total cost of 40 cents per net ton.

The above is figured on a cost basis, while some prefer to figure the rejection cost on the basis of the selling price. In other words, if the above coal before cleaning sold for $2.25 per net ton f. o.b mines, and the cleaning cost, power, labor and overhead was 20 cents, the cleaning cost is expected to be obtained from the consumer, keeping the mine margin the same and this 20 cents added to the $2.25 would give $2.45 per net ton. Due to the rejection of 10 percent in the cleaning, this $2.45 should be divided by 90 or showing a price of $2.72 which is 47 cents more than the price realized before cleaning.

From a practical standpoint a mine does not go into the cleaning game unless its coal as shipped is too dirty to insure it a fairly good continuous market and good operating time, which would affect its cost. Therefore the rejection cost should not be figured as a direct cost against the cleaning of coal but each item of cost of operation should carry its burden of the refuse rejection by having the total mine cost figured on the basis of railroad weights of coal as shipped, the cleaning cost to stand only the power, labor, maintenance and depreciation charges.

This last method should be used when figuring one type of cleaning process as against another, because if a coal is of such a character that 10 percent rejection is necessary to put it in a marketable condition, then any plant that is put in, if it operates satisfactorily will reject this 10 percent and the cost would be the same, and the actual washing or cleaning cost is what is wanted when it comes to deciding which process will be the most economical.

From the present methods used in the buying and selling of bituminous coal, it is practically impossible for any commercial plant to figure which is the most economical thing for it to do in the cleaning of its coal, and it has about resolved itself into a plant doing just what it has to do in order to move its product into an oversold market and be able to sell its product fairly evenly over the year to insure a good average run for economical plant operation.

When the time arrives when coal is sold on quality alone and a premium

*Humphrey D. Smith*

paid for each percent of ash reduction, which takes also into consideration the analysis of the coal, moisture content, fuel value, etc., then it will be possible to figure for any plant how far it can go economically in the cleaning of its coal.

The investment in a cleaning plant, is one of the largest items in the cost of cleaning coal, and in several plants which the writer is familiar with, this item represents at least half of the cleaning costs.

Most every type of washery or cleaning plant is made up of a number of units which have a definite capacity for a certain size of coal to be cleaned. If the plant in question has a capacity to fit the maximum capacity of the unit whether it be a jig, wet or dry table, or other type of washery units, the investment in this plant per ton of annual output will of course be less than a plant which does not have capacity enough to take advantage of the maximum capacity of the unit in question. This holds good with all the equipment going into a cleaning plant, namely, the elevating and conveying machinery, the screens and other machinery incidental to the particular plant. This also applies to the building structure proper. As an example it has been found possible to build a washery for a mine getting out 800 tons per day of which 400 tons is to be treated for $65,000.00 which would be on a basis of 28 cents per ton of total annual output of 240,000 tons. This same plant could take care of 1,400 tons per day, 700 tons being treated, plant having annual output of 420,000 tons and the investment would only be 15 cents per ton.

This is partially due to the number of units necessary to treat the particular sizes, in one case the units being part loaded while the other has each unit fully loaded, also to the extra size of the elevating and conveying units costing less per ton capacity as the capacity increases. The same applies to the structure proper.

In general it might be stated that large capacity washers can clean coal more efficiently and more economically than smaller ones, although there are so many conditions and factors entering into a cleaning problem that no stated facts that will hold for one plant would be satisfactory for another.

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***COLONEL WARREN R. ROBERTS**, President, Roberts and Schaefer Co., Chicago, Ill.*, led the discussion following Mr. Smith's remarks, and pointed out that:

"In speaking of the preparation of the larger sizes of coal, especially for domestic purposes, Mr. Smith states that this coal has been successfully cleaned mechanically up to 5 in. and down to slack sizes. He doesn't state by what methods. They could be cleaned by both the dry and wet processes at least up to 3½-in. sizes. Coal has been successfully cleaned on dry tipples up to 3½ and successfully with the wet methods up to 5 in.

"In the discussion of the pea and nut sizes, I think he is very optimistic in thinking that it is economical at any time to pick even nut sizes. The only time that the picking of nut sizes is justifiable is when it is going to domestic trade and contains a sufficient large amount of free rock and slate, and when improvement in its appearance will help to sell it.

"When it comes to reducing the ash in nut coal by hand picking, there is not enough reduction made, according to very careful tests that we have run at various mines, to pay for the cost of picking, when you figure the actual ash reduction. However, if you are selling it, as I say, to a trade that will take it on appearance, the improved appearance due to cleaning may be helpful.

"Mr. Smith says: 'From a practical standpoint a mine does not go into the cleaning game unless its coal, as shipped, is too dirty to insure it a fairly good, continuous, market and good operating time, etc.' That statement was correct in the past, but it is not true at the present time and will not be true in the future. I believe in the past it was entirely right and practical for a man to reach a decision as to whether he could clean his coal on the basis of that sort of argument. That doesn't however hold good any more. There are too many factors involved, as Mr. Smith has already pointed out in his paper.

"His paper leads one to this conclusion: That before you decide on cleaning any part of your product at a mine you should run careful tests and learn where your impurities are in your coal, and to what extent each size of coal as it is marketed contains impurities. It will be very surprising to you often, after a car load test has been carefully run,

to find just where your impurities are, whether they are higher in egg and nut or whether they are higher in nut and pea, or whether they are higher in pea and slack."

***MR. ERSKINE RAMSAY,*** *Consulting Engineer, Alabama By-Products Corporation, Birmingham, Ala.:* "Down in Alabama as you all know, we have very wonderful natural resources. We have broadcasted that to the world. We haven't been so particular to broadcast the fact that it is necessary for us to wash practically all of our coal. In fact, when the world war began, I think Alabama had the distinction of washing 40 percent of all the coal washed in the United States.

"When I first went to Alabama some years ago we weren't washing any coal at all and after awhile it became necessary to wash the coal in order to get into competition for making pig iron. The manager of our company brought the Robinson washer over from England. We put it in a plant in Birmingham first of all. From then on we added other washers until finally we were washing all of the coal that went into coke, of course, making a very much better grade of coke. We found that as you added washers the coal miner became a little less particular about keeping the coal clean and our percentage of refuse ran anywhere from 10 to 15 percent. In other words, for every 100 tons of material brought out of the mines we had a washed coal of 85 or 90 tons. Later on there was a consolidation of two mines operated with convict labor. At that time one of them burned down and in rebuilding it we found it wasn't practical to arrange it the way it had been arranged before.

"We put in a plant without any arrangement for the hand picking of the coal foreseeing that that would give us a dirtier coal. We put in a plant to sample a large portion of the mine cars dumped. We put in this plant and kept our records without saying anything to the miners. We found that for every 100 tons of material hoisted out of the shaft after washing we shipped away, as washed coal, 76 tons. So 24 tons of that was waste.

"Then we began publishing, or making public, these results. We took a large sheet at the prison and in the evenings when the work was over the warden would read off the records. Inside of two weeks, and without punishing the men in any way or giving them any kind of a bonus for every 100 tons that they hoisted out of the mine, we were shipping away as washed coal 82 tons and 18 tons went on the dump. That made a difference in our cost of operating at that one mine, at that time, a little over $5,000 a month. Later on, the Woodward Iron Co., of Alabama, put in these samplers at all of the mines. They are all free mines. Before putting them in they were putting 20 tons out of every 100 on the waste dump. After using this system of sampling, a large proportion of the mine cars dumped produced 85 percent. They cut that down to what is now their present practice of 10 tons going on the waste dump.

"'That difference between 10 and 20 tons out of the 100 means to them, in the course of a year, $250,000. They have adopted the plan of penalizing the men for dirty coal. They established a base line and anything that had a higher percentage of refuse than that they would reduce the base price on. Where it was cleaner than that they would give a bonus. The bonus scale is about twice as high as the penalty scale. They find that they collect about as much from the men in dollars and cents as they give to them.

"To my way of looking at it, that plan of sampling the mine cars will come nearer to getting clean coal than any other way I have seen tried. As I said, the Woodward Co., at their present three coal mines, sample 80 percent of the total mine cars. They have a new shaft operation which is to have a capacity of 5,000 tons a day and will eventually take the place of the other mines. They will get the coal out cheaper and eventually shut the others down. They have their designs all made now to sample for comparison. The cars will hold about a ton and a half. Roughly speaking they will take about 3,000 samples a day. These samples run around 100 pounds. It might run from 50 to that. At two of these plants they have slope operations. They hoist out 5 car trips in one plant and 5 car trips at the other. Both of these plants are equipped with Ramsay rotary dumps. One of the problems was in taking the sample from the mine car. They wanted to arrange it so the sample wouldn't always be taken from the same part of the car. If you took it from the same end of the car all the time the miner knew it and he would put the dirty coal in the other parts of the car.

"As these 5 to 6 cars were turned over on the chute for catching the samples, the chute might be at the front end of the car once, in the next car it might be in the middle, and on the next one it may be at the other end and so on down the line. You would be taking your samples from different parts of the car and the miner wouldn't know from what part it was going to be taken.

"The sample when taken is passed over a small, rather fast moving shaking screen and that screens out everything from ½-in. down. Below ½-in. is discarded. I think that probably it ought not to be. I believe the final development will be that the fine stuff will be determined also. It won't be done with the idea that the miner should pick out the ½-in. and less. If he knows that that won't be analyzed or tested, naturally he, at times, will scrape in a lot of fine stuff that he knows quite well is very, very dirty, but if he knew the price for his coal was going to depend on the quality of that fine stuff he would be more careful with it.

"Regarding the stuff that goes over the screen at ½-in. or over, we have a man on either side and they very quickly pick out the rock. When they get through treating that sample they have two compartments there, one with the clean coal above ½-in. and the other with the rock above ½-in. Those are put on the scales and weighed and the number of pounds of slate is determined in the coal. That determines the quality of the car, that is, the whole car, and the miners are paid according to that determination.

"I think, as I said before, that there ought to be some development whereby quality of the entire sample could be taken. That would mean the quality of the entire car. The size of this sample of 100 pounds in this particular case is taken out of the car, which holds about 3,000 pounds, so that that is 1/30 of the entire car. The point is sometimes raised that that sample is probably not fair as regards the entire quality of the car. Probably it isn't, but on the whole it will average up pretty well. The Woodward Co., has three men to sample, and at a mine that is putting out about 1,500 tons per day, with three samplers it would mean nine men altogether. If they didn't have that sampler they would have some hand pickers picking the entire car by hand and putting the slate in the powder kegs. Then you know if you get over one keg you raise the devil with them about it. If you get less everything is all right. In that case you pick one car out of a hundred. The average man is human and he takes a chance on being caught. When he is caught he consoles himself with the fact that he was just getting even for the times that they didn't catch him."

***MR. J. B. MORROW,*** *General Outside Superintendent of the Stag Canon Branch, Phelps-Dodge Corporation, Dawson, N. Mex.:* "In connection with the cost of hand picking of coal, a short time ago I had occasion to make a detailed test of that. I have actual figures which might be of some interest.

"Our lump coal is over 6-in. The egg coal is 3 by 6, our nut coal is 2 by 3. The flow of coal over the belt at the time of picking, on the lump coal is 38.6 tons per hour; 9 percent of the material was picked out of that as waste. On the egg coal it was 34 tons per hour; 37 percent of that was picked out as waste. On the nut coal it was 23 tons per hour over the belt and 15 percent of that went out as waste. To give you an idea of the actual cleaning done on that coal: the lump coal, previous to being picked was 18 percent in ash, when it was picked it was only 15. The actual bone and rock that was picked out of it was 33 percent ash. The egg coal ran 18½ and it was cleaned down to 15½. The waste matter picked out was 28½ percent ash. The nut coal was 18 percent ash; picked out it was 15.7 and the waste was 37 percent ash. The waste matter is not all waste because it can be pulverized. We figure the cost of the coal as just one-half.

"It costs $2.50 a ton and we credit that back at $1.25 a ton which is the actual cost of operation. On the lump coal the cost is 7 cents per ton for the actual cost of picking labor. The waste cost on the lump is 19 cents. In other words, the waste cost is about 2½ times the actual cost of the picking. That gives us a total cost of 26 cents. On egg coal it costs 14 cents. The cost of the waste picked is 25 cents a ton. The actual cost of picking that egg coal is 38 cents. On the nut coal it costs 18 cents to pick and it costs 22 cents for the waste. The total cost of the nut coal is 40 cents.

"I bring those figures out in connection with what has been said, that sometimes the cost of picking is so high that if it isn't carefully looked into you find there isn't very much money in it."

MR. RAMSAY: "I might say on that matter of cost, that at the Woodward mines, roughly speaking, the picking would cost about 2 cents a ton on their output. They do increase their production at a 1,500-ton mine about 150 tons a day. Assuming that that coal costs them $2 a ton, that means about $300 a day they are getting for spending about $30 a day."

# PREPARATION OF BITUMINOUS COAL BY THE SAND FLOTATION PROCESS

*Nine Reasons For Selection Of Sand Flotation Process—Operating Results Tabulated And Analyzed—Weather Conditions Shown Of Greater Effect On Moisture Content Than Cleaning Processes—Nineteen Months' Continuous Operation Wholly Satisfactory*

*By* J. WILLIAM WETTER *

BEFORE discussing in detail the initial application of the Chance Sand Flotation Process to the cleaning of bituminous coal, it might be well to recite briefly the circumstances under which this process was adopted for the cleaning of Rockhill coal.

This coal originates from six mines located in Fulton, Bedford, and Huntingdon Counties, Pennsylvania, owned and operated by the Rockhill Coal & Iron Co. These mines are situated about 30 miles from the town of Mt. Union on the main line of the Pennsylvania Railroad and they are served by a narrow-gauge railroad. The coal car equipment on the latter consists of steel hopper cars having a capacity of from 30 to 35 tons.

This coal was transferred by spotting the narrow-gauge equipment on a trestle from which the coal was dropped into the Pennsylvania Railroad standard-gauge equipment, so that there were no preparation facilities.

In 1914, a transfer tipple was erected at Mt. Union. It was of the Link-Belt design and consisted of two duplicate units having a gross capacity of 500 tons per hour. Facilities for screening out lump and egg sizes were provided, also picking tables and loading booms, so that it was possible to ship a hand-picked product of run-of-mine, lump, and slack.

In the year 1920, a domestic market was developed for lump, egg, and nut sizes, and one of the duplicate units was rearranged so that a product of plus 4½-in. lump, 4½-in. by 2-in. egg, 2-in. by 1-in. nut, and minus 1-in. stoker sizes could be shipped. The lump, egg, and nut sizes were hand-picked. Therefore, in making this change, one unit with a capacity of 250 tons per hour was employed to make sized coal and stoker and the other unit, with a like capacity, for run-of-mine.

Under these conditions, 28 men were employed as pickers on the sized coal, and the total force required to operate the tipple, including the dumpers, trimmers, shifters, etc., amounted to some 40 men. The products shipped were not uniform in quality as the egg and nut sizes were relatively high in ash and sulphur due to the inefficiency of hand picking. In addition to this, no attempt was made to clean the stoker coal and a series of analyses of this product showed widely varying results, both as to the ash and sulphur content. With 28 pickers, the refuse removed amounted to approximately 1 percent of the input coal.

In the year 1924, it was decided to increase the capacity of the mines and to expand the market for Rockhill coal. To accomplish this it was necessary to increase the capacity of the Mt. Union tipple and to improve the preparation to a point where an absolutely uniform product would be secured, as a ready market existed for this coal if properly cleaned. To increase the capacity of the plant was not a difficult matter. However, the securing of an absolutely uniform product and adhering to the hand-picking method of cleaning did present a difficult problem. From the results obtained, it was felt that the installation of additional hand-picking facilities was not warranted either from the standpoint of production or labor cost of preparation. This was especially true of the 2-in. by 1-in. nut size and, of course, the hand-picking method would not in any way benefit the minus 1-in. stoker product. It was therefore decided to make a thorough investigation of every known method of mechanical cleaning.

*J. W. Wetter*

The study of this problem consumed the better part of 18 months, during which time extensive tests were made of the raw product delivered to the Mt. Union tipple and definite information was gained as to the maximum results, from the standpoint of clean coal and uniform quality, that could be expected if a proper mechanical cleaning method were employed. The detail of these tests consisted of closely screening various sizes and applying the ordinary laboratory float and sink tests at various specific gravities. These tests proved conclusively that by thorough cleaning an infinitely better product of egg and nut sizes could be produced, and that by cleaning the stoker size from 1-in. down to 3/8-in., a very uniform product with lower ash and sulphur content could be made and shipped.

The next step was to make an investigation of the mechanical cleaning methods most suitable for the work, these methods falling under two general classifications, namely, dry cleaning and wet cleaning. While, at the start, a great amount of opposition developed toward the wet process because the wetting of the product was deemed objectionable, nevertheless both methods were thoroughly gone into, and when the investigation was concluded it was found that the opposition to the wet method was based more on prejudice than on fact.

The Sand Flotation Process was finally agreed upon for the following reasons:

(1) It is a commercial float and sink apparatus, the separation of the coal and refuse taking place only because of the difference in the specific gravity of the materials treated, thereby eliminating any variation in the quality of the coal or refuse products because of the shape of any individual piece or particle, the character of its surface, or variation in moisture.

(2) The fact that close screening was not necessary, it being possible to secure an efficient separation by putting all sizes in one machine, or as is the case at the Mt. Union tipple, sizes of from minus 4½-in. to plus 1-in. are placed in one machine and sizes of from minus 1-in. down to plus 3/8-in. are placed in another machine.

(3) Because there is no re-circulation problem involving the production of so-called middlings unless such product is desired.

(4) The variation of the quality of the feed—its refuse content—makes no difference in either the coal or refuse products from the machine.

(5) Variation in quantity of feed to the machine has no effect on separation.

(6) The process had been successfully applied to the cleaning of anthracite coal and, therefore, had passed the experimental stage.

(7) From a study of the anthracite plants in operation, it was found that operating and maintenance costs were low.

(8) Extreme flexibility of the process was demonstrated by anthracite installations.

(9) The installation cost for the capacity desired was found to be the lowest of any method investigated.

Due to the difference in character between anthracite and bituminous coal, questions arose during the investigation as to whether results could be expected similar to those obtained by the application of the Sand Flotation Process to anthracite coal. One of these pertained to the removal of sand which it was thought might lodge permanently in the crevices of the soft coal, and the other related to the moisture which might be added to the product by using a wet process. These questions were definitely settled by the results secured by actually installing a small flotation cone through which unclean coal, of the sizes to be treated, was passed. It was surprising to note the ease with which the sand was

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removed from the coal as well as the relatively small amount of moisture added, notwithstanding the fact that a rather crude screening arrangement was used. This small test cone also demonstrated the high efficiency of separation and the flexibility which could be expected.

After reaching a decision to install the Sand Flotation Process, plans were commenced for remodelling the existing plant and building the necessary addition to house the flotation cones, and the plans were completed about May 1, 1925. The actual installation work was started July 1, 1925, and the entire plant was completed and placed in operation on October 1, 1925.

In making the conversion from a hand-picking plant to a mechanical cleaning plant, it was necessary to arrange the work in such a manner as not to interfere with or interrupt the transfer of coal. While this somewhat hindered the erection of the steel and the installation of the machinery, the plant was nevertheless completed in such a manner that the transfer of coal was interrupted for only two full days. The plant was changed over under rather adverse conditions as the space was limited and the old plant did not lend itself favorably to remodelling.

Briefly, the conversion of the plant from hand-picking to mechanical cleaning consisted of installing a set of four vibrating screens, two flotation cones each 10 feet in diameter, de-sanding, dewatering, and sizing shakers, together with the necessary auxiliary equipment, such as feeder conveyors, sand and water pumps, sand sump, etc.

The flow of the coal through the plant is as follows: Coal is dumped from the narrow-gauge railroad cars into two track hoppers, each with a capacity of about 100 tons. It is fed from these hoppers to two inclined pan conveyors by means of push feeders. These two conveyors discharge on an ordinary type shaker screen, the screen consisting of a plate with 4½-in. round perforations.

The oversize or plus 4½-in. material goes directly to a picking table where it is hand-cleaned by two pickers. The undersize or minus 4½-in. material is conveyed by a 42-in. by 10-in. flight conveyor to a battery of four Shiley vibrating screens. These screens are dressed on the top decks with 1-in. square wire cloth and on the bottom decks with 3/8-in. square wire cloth. The oversize from both decks passes to a divided flight conveyor, the minus 4½-in. by plus 1-in. material falling into one division and the minus 1-in. by plus 3-in. material falling into the other. This divided flight conveyor discharges onto two inclined belts which feed to and discharge into the two cones, one thereof taking the 4½-in. by 1-in. material and the other taking the 1-in. by 3/8-in. material.

After passing through the cones, the cleaned coal product from each cone discharges onto two de-sanding and dewatering shakers. The 4½-in. by 1-in. material can be sized on these shakers so as to make a 4½-in. by 2-in. egg size and a 2-in. by 1-in. nut size and can be delivered directly to separate loading booms or, by closing gates, both of these sizes can be discharged onto a mixing conveyor.

The coal coming from the cone handling the 1-in. by 3/8-in. size also passes to a de-sanding and de-watering shaker and from there discharges directly onto a mixing conveyor. The minus 3/8-in. undersize coming from the vibrating screens is also discharged directly onto the mixing conveyor.

This arrangement permits the making of either a run-of-mine product (the cleaned coal plus the undersize from the Shiley vibrators being combined with the hand-picked lump), or lump, egg, nut, and stoker sizes can be made, or any combination of these sizes.

The rock or refuse removed from the coal in the cones is discharged at the bottom of the cones into a water-sealed conveyor, whence it is discharged onto a shaker and from there deposited into a Clark automatic-dump car.

The sand and water removed on the coal shakers, also on the rock shakers, is returned to a settling sump consisting of a concrete conical tank 21 feet in diameter.

Both the sand and the water are recirculated continuously and a supply pump delivers from the dam into the sand sump about 250 gallons of fresh water per minute. No attempt is made to de-silt the waste water as an abundance of fresh water exists. Figures have been worked out on this, however, and it has been found that if settling tanks were installed, one such tank with a diameter of from 15 to 20 feet would de-silt this water satisfactorily so that, by returning the clarified water, the supply of fresh water needed would be reduced to from 25 to 50 gallons per minute.

## Operating Results

A general summary of the operating results of this plant for the year 1926, is as follows:

| | |
|---|---|
| Total net tons prepared and shipped | 632,750 |
| Total days worked | 279 |
| Average days worked per month | 23.25 |
| Average net tons handled per day | 2,268 |
| Maximum net tons handled in one day (7 1-3 hours) | 4,441 |
| Total tipple and loading crew | 24 |
| Allocated preparation crew | 6 |
| Sand consumption in pounds per net ton of coal shipped | 2 |
| Power consumption K-W hours per ton of coal shipped | 0.892 |
| Preparation in man hours per net ton of coal shipped | 0.021 |
| Preparation maintenance cost per net ton of coal shipped | 1.5c |
| Total capital charges per net ton of coal shipped | 2.0c |

The above figures cover the entire operation of unloading, cleaning, and screening except the items noted under "Preparation," which latter cover cleaning and screening alone.

| Loaded | | Lbs. | Change in original weight | Weather |
|---|---|---|---|---|
| April 27 | 9.13 a. m. weighed 9.17 a. m. | 141,900 | None | Clear |
| April 27 | Reweighed after 8 hours | 141,900 | None | Clear |
| April 27 | Reweighed after 12 hours | 141,900 | None | Clear |
| April 28 | Reweighed after 16 hours | 141,920 | + 20 lbs. | Slight rain |
| April 28 | Reweighed after 24 hours | 142,340 | +440 lbs. | Showers |
| April 29 | Reweighed after 48 hours | 141,880 | — 20 lbs. | Clear and windy |
| April 30 | Reweighed after 72 hours | 141,880 | — 20 lbs. | Clear and windy |
| May 1 | Reweighed after 96 hours | 141,880 | — 20 lbs. | Clear, high winds |

## Analytical Results

The following analyses of samples taken simultaneously from the domestic cone unit will give an idea of the results obtained:

| | Ash | Sulphur | B. T. U. |
|---|---|---|---|
| Raw coal (4½" x 1") | 17.75% | 1.58% | 13,680 |
| Washed coal (4½" x 1") | 7.42% | 1.10% | 14,580 |
| Refuse (4½" x 0") | 58.60% | 3.59% | 5,602 |

It should be noted that these sizes contain a concentration of high ash impurities in the raw coal as the raw run-of-mine coal contains but 9.5 percent to 10.5 percent of ash. The refuse contains less than 2 percent of material that will float at the specific gravity maintained in the cones, and the coal after it comes from the cones contains even less than this amount of material that will sink at such specific gravity.

The average reduction in the run-of-mine product is 2.5 percent in ash and 0.75 percent in sulphur. The limits of fluctuation in the ash and sulphur are 0.75 percent in ash and 0.20 percent in sulphur.

Many tests have been made to determine accurately the effect of the Sand Flotation Process on the moisture content of the shipped product. One consumer made an independent test showing the increase in moisture to be about one-half of 1 percent. It has been a regular practice to take samples of the stoker coal as it is loaded and also samples of the by-passed minus 3/8-in. coal for the purpose of making moisture determinations. It was found that the weather conditions greatly affect the shipped product and in wet or stormy weather the moisture content increases. The table above shows the results obtained by an independent chemist, as to moisture, from samples taken from cars containing stoker coal and also samples of the minus 3/8-in. by-passed coal secured at the same time as the stoker coal was being loaded. This table also shows the weather conditions on the dates of shipment.

To further show the effect which weather conditions have on the moisture content of the coal, a car of stoker coal was weighed immediately after loading and then re-weighed at various intervals for a period covering 96 hours, noting the weather conditions. The results of this test are shown in the table below.

It will be noted that at one time after a shower the weight increased 440 pounds, but after 48 hours of clear

| STOKER COAL | | | | | | BY-PASS COAL | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Size of Coal | Sample | Moisture | Ash | Sul. | Date | Size | Moisture | Ash | Sul. | Weather |
| 2/16/27 | 0"-1" | From 2 cars | 5.41 | 7.37 | 1.22 | 2/16/27 | 0"-¾" | 4.20 | 7.68 | 1.36 | Snow and rain |
| 2/19/27 | 0"-1" | From 9 cars | 6.69 | 7.61 | 1.23 | 2/19/27 | 0"-¾" | 5.95 | 7.08 | 1.16 | Snow |
| 2/18/27 | 0"-1" | From 10 cars | 4.85 | 7.62 | 1.46 | 2/18/27 | 0"-¾" | 4.29 | 8.27 | 1.73 | Cloudy |
| 1/10/27 | 0"-1" | From 2 cars | 4.75 | 7.40 | 1.33 | 1/10/27 | 0"-¾" | 3.99 | 8.31 | 1.61 | Clear |
| 1/ 8/27 | 0"-1" | From 2 cars | 4.73 | 7.04 | 1.098 | 1/ 8/27 | 0"-¾" | 4.02 | 7.56 | 1.31 | Clear |
| 12/24/26 | 0"-1" | From 9 cars | 4.70 | 7.79 | 1.137 | 12/24/26 | 0"-¾" | 4.13 | 8.00 | 1.38 | Rain |
| 12/17/26 | 0"-1" | From 2 cars | 4.29 | 7.65 | 1.26 | 12/17/26 | 0"-¾" | 3.70 | 7.99 | 1.40 | Clear |
| 12/15/26 | 0"-1" | From 7 cars | 4.51 | 6.88 | 1.21 | 12/15/26 | 0"-¾" | 4.01 | 7.56 | 1.25 | Snow |
| 12/13/26 | 0"-1" | From 2 cars | 4.67 | 6.72 | 1.06 | 12/13/26 | 0"-¾" | 4.13 | 7.12 | 1.34 | Cloudy |

weather and high winds the weight was 20 pounds less than at the time the car was originally weighed.

To further show that weather conditions have a far greater effect on the moisture content of coal in transit than has a wet cleaning process, the following is given: A separate mine was selected having hand-cleaning facilities only. Moisture determinations were made from samples taken from the railroad cars at the time of loading covering a period of 12 months. Moisture determinations were also made from samples of this same coal over a like period upon arrival at destination. The moisture content at the mine varied from 1.2 percent up to 2.1 percent with an average of 1.45 percent. The moisture content at destination varied from 2.2 percent up to 5.2 percent with an average of 3.48 percent.

The above tests confirm that the small increase in moisture which the coal has when shipped from the plant is immaterial when considered in connection with the effect which rain or snow has upon the coal in transit to the consumer.

### Conclusions

After continuous operation of this sand flotation plant covering a period of 19 months with shipments running over a million tons, it has been proven conclusively that it is giving the desired results and is in every way a commercial success, and from an operating standpoint it has proven to be very economical. The few interruptions occurring have been of a trivial nature and during the period of operation there have been no interruptions curtailing the shipment of coal. From an analytical standpoint, the product produced is of uniform high quality, while from a sales standpoint the product has met with general approval, resulting in an expanded market and an enhanced value. This process has been so satisfactory that consideration is now being given to the installation of additional plants at other bituminous mines.

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***MR. T. M. CHANCE,*** *Chance Coal Cleaning Co., Philadelphia, Pa.,* led the discussion following Mr. Wetter's paper.

"There are some points that might be of interest in reference to the general condition of operation that Mr. Wetter hasn't touched upon. The plant in question has been in operation for about 18 months so the data to be had are rather alive. The units themselves are designed for treating coal up to 6 in. in diameter. The only limitation on size that that type of machine can handle is the size of the refuse that is going to be trapped. With the 22-in. classifier pump they can handle 6-in. stuff. We operate them on 4½-in. lump, as there is such a small amount in the 4½-in. lump that it wouldn't justify any further classification. The units can be built to handle 8 and 10-in. lump if that is desired.

"At Mt. Union we treat over 66 percent of the coal and on the fine sizes we found a low moisture which is rather peculiar in a tonnage where such a large percentage is washed. It is simply due to the fact that we don't get the sludge with the larger sizes, that is not a large percentage of it. There may be 25 or 30 percent of the minus ⅜ that goes to the machine. We don't screen for the sake of screening. We screen to get out raw coal which will be dilatorious if wetted.

"The only reason that we by-pass minus ⅜ or minus ¼-in., depending on the condition of the coal in the lump, is to eliminate the moisture problem. We have found that if coal goes through 4½-in. and over ⅜ or a ¼ it is probably properly cleaned, practically down to the inherent ash. The small amount of minus ¼ or ⅜ present, even though it may be of higher ash content than you would like to have, will not dilatoriously hurt the resultant. That applies not only to the run-of-mine but the 1 in. stoker coal.

"There were some figures given awhile ago in the discussion of Mr. Smith's paper. At Mt. Union we had 28 pickers and the maximum tonnage that they could put through was 258 tons per hour. That was not due to condition of the mine but it was how much coal could be put through. Under such conditions the egg coal and the nut coal were not of the low ash content desired. When they run 250 tons per hour they only prepare 40 percent of the product and 60 percent was absolutely raw coal. The result was that 28 men picked 100 tons an hour and the labor for preparation, with nothing allowed for screening and attendance and nothing for any machinery just taking into account the hand picking, was 3.55 tons per man, per hour, with a product that was not, as I understand it, satisfactory.

"At the present time in that plant we repeatedly receive 550 tons per hour. That is the tonnage they go through. They have 6 men allocated to the preparation, screening, cleaning and picking, and of those, 2 men are pickers. Those men cleaned 85 percent of the 550 tons an hour. In other words there is 15 percent that we don't include in the man hours per ton of cleaned coal or shipped coal. So, those 6 men produce 466 tons an hour as against the 28 men producing 100 tons per hour. They have a tonnage per man hour of 66.6. The mechanical operation has rather convincingly shown the difference in labor.

"In reference to the matter of sand, the situation at Mt. Union is rather a happy one. Mr. Wetter gave a figure of 2 pounds of sand per net ton of coal shipped. On the basis of 4½-in. prepared product this 15 percent of dry findings is in with a washed product. It is part and parcel of the tonnage just as much as if it had been cleaned. It mustn't be lost sight of that variation in ash analysis due to the raw coals change this characteristic and the same thing applies to sulphur.

"In reference to the water we have found that this recirculation bituminous operation of dirty, foul water doesn't effect the treatment of the coal a particle. We have a 3-in. pump and we designedly use a trick. That pump handles around 250 gallons. That amounts to 42 gallons per ton of washed coal and that water is designedly run to waste. There is no effort made to collect it because the percentage of solids in it doesn't justify it. On the whole tonnage that amounts to 30 gallons. So to gentlemen familiar with settlers I would say if you have to make up that loss the thickening problem is not quite what you would think. It isn't serious at all.

"On this particular coal we have records of over 300 cars that were shipped, which show moisture contents, some below and some above the 1-in. stoker that is now used. That was on, almost entirely, a 300 or 400 mile haul. That depends too on destination of the coal. I think some gentlemen here today will agree with me that coal does take up moisture if it goes through a heavy rainstorm.

"At Mt. Union we hauled the coal a certain number of miles before it was cleaned. A dry fine would then run in excess of 4½ to 5 percent of moisture. We have hauled some coal less than 600 miles at Mt. Union and yet we had the moisture increased to over 7 percent before it was ever put into the plant. That accounts for the average over a year's operation of about .5 increase in moisture over that which the coal normally would have for the run-of-mine."

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The Special Committee on the Necessaries of Life of Massachusetts has issued a memorandum relative to household fuels, and it is pointed out that a study of the household fuels used in Massachusetts during the last coal year —April 1, 1926, to March 31, 1927— shows that the 950,000 homes in the commonwealth consumed the fuel equivalent of about 8,000,000 tons of coal for heating and cooking purposes. The price paid for this fuel amounted approximately $120,000,000.

It was found that anthracite is the principal fuel and deliveries of domestic sizes amounted to 5,100,000 tons. The dealers report sales of about 150,000 tons of buckwheat during the year.

It is estimated that about 600,000 tons of low volatile bituminous were sold for heating apartment and other dwellings, most of which was run of mine. A large additional tonnage of bituminous was used in heating offices and other large buildings.

Dealers report deliveries of approximately 135,000 tons of coke, the bulk of which was purchased from Massachusetts ovens. The Massachusetts coke ovens report sales of 435,000 tons of heating coke, and this is an increase of about 60 percent over sales of a few years ago.

Dealers report deliveries last year of approximately 125,000 tons of briquets. Sales of oil for heating purposes amounted to 48,000,000 gallons, exclusive of heavy fuel oil, and this is estimated to be the equivalent of about 300,000 tons of coal. The use of gas for space heating has not yet assumed very large proportions, approximately a thousand homes being heated by gas in Massachusetts last winter. It is estimated that gas and electricity for cooking and heating purposes supplied the fuel equivalent of about 1,250,000 tons of coal last year.

The commission notes that there are 800 recognized retail coal dealers in Massachusetts and 158 gas, coke and electric companies. Competition between the different domestic fuels, the commission finds, is becoming keener. Ten years ago anthracite was used almost exclusively for house heating and cooking.

# CLEANING COAL AT PHELPS DODGE CORPORATION

***On Account Of Proximity To Metal Fields, Practice Has Been Influenced Considerably By Ore Concentrators—Operating Costs Average 17.5 Cents Per Ton Although This Would Be Materially Reduced By Full Time Operation—Twelve Percent Ash Average***

*By* J. B. MORROW*

THE Dawson coal, which is mined from what is commonly known as the Raton seam, is typical of a certain class of western coals with high ash and carrying a large percentage of true bone product. While there is a certain percentage of laminated material yet fine crushing does not improve the separation characteristic as much as might be expected, particularly in the higher ash coals.

The following table shows the percentage of coal at varying ash in the 1½ in. slack and also on the same material crushed to ⅛ in.

| Material | % ash washed coal | | | | |
|---|---|---|---|---|---|
| | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 |
| % coal, 1½ slack | 68.2 | 76.3 | 82.2 | 86.8 | 90.0 |
| % coal, crushing to ⅛ in. | 75.2 | 81.3 | 85.7 | 89.2 | 91.9 |

The specific gravity separation of the average washery input is as follows:

| Sp. G. | % sample | % ash |
|---|---|---|
| 1.35 | 63.7 | 8.7 |
| 1.35 to 1.55 | 19.9 | 22.6 |
| Sink @ 1.55 | 16.4 | 53.0 |
| Total | 100.0 | 18.7 |

Combining the bone with the coal we have:

83.6% coal @ 12% ash.
16.4% rock @ 53% ash.

In other words for a 12 percent ash in the washed coal a tailings with 53 percent ash is the highest that can be expected and if this ash was attained would carry no free coal. This figure of 12 percent ash is about the average of the washed coal over a period of years though on special coke orders we occasionally operate at 11 percent ash.

Besides the coal from the mines the washer also handles the pickings from the commercial coal preparation. In late years when running at low capacities at the washery this has run from 5 to 10 percent of the total input. This material has a composition as follows:

| Sp. G. | % sample | % ash |
|---|---|---|
| 1.35 | 30.4 | 8.8 |
| 1.35 to 1.55 | 23.6 | 23.0 |
| Sink @ 1.55 | 46.0 | 50.0 |
| Total | 100.0 | 31.1 |

During periods when there was a scarcity of coal we have also operated with the old waste dumps which averaged about 40 percent ash and carried up to 50 percent of recoverable coal at 13 percent ash.

Previous to 1908 the coal was washed at a size from 1½ in. down in jigs of the Forrester type used as primary units without any rewash. This plant was not very efficient on this class of coal as analyses of the waste dumps showed 35 to 40 percent ash with approximately 50 percent of recoverable coal.

In 1906 a new plant was built handling the coal at the same size, first washing in Stewart jigs and then screening the tailings over a ¾-in. trommel, the undersize going to Luhrig jigs and the oversize being rewashed on another Stewart jig to make a pea coal with 18 percent ash for the commercial trade. This was a distinct improvement over the old plant as the tailings averaged 45 percent ash for the same washed coal. When this plant was first started there was only 5 percent of material under ¼ in. in the washery feed, but this gradually increased up to 30 percent in 1910. This was not a satisfactory product for the Stewart jigs and the hutch from the Luhrigs carried about 50 percent of recoverable coal. Additional primary Luhrig jigs were then put in to handle the screened fines from the washery feed. This improved the performance of the Stewart jigs but we still had the trouble with the excessive loss in coal in the Luhrig jig hutch matter.

Some experimenting had been done with the Wilfley table in 1906, but though the results were encouraging, the small capacities obtained at that time had precluded their use on a commercial scale. In 1910 it was decided to try it again and by developing a larger deck than that used in metal practice it was found possible to make a very good separation with a capacity of six tons per hour used as a primary unit on coal below ¼ in. It was decided to put in an experimental plant at first rather than remodel the entire mill; so 24 tables were installed in a separate building, 20 of these being primary and 4 secondary tables. This plant handled the fines below ⅜-in. in the washery feed, the oversize going to the Stewart and Luhrig jigs in the old plant and the Luhrig jig hutch was also sent to the tables.

The results from this plant being very satisfactory, it was then decided to remodel the entire washery in order to reduce the operating cost. It was the first thought to crush the entire feed to minus ¼-in. and put in an all table plant, but when considering the problem of the water settling system and the drying of the washed product it was thought more advisable to crush to ¾-in. and use jigs as a primary unit and the tables as a clean-up. We expected to be able to get the same results as it was desired to obtain from the table plant and do it at a lower operating cost. Subsequent results have been such that we have been well satisfied with this installation.

The flow sheet of this plant which was operated from 1916 until it was shut down in 1926, on account of the copper smelters abandoning the use of coke, is as follows:

The coal is crushed to minus ¾-in. and all goes to three Faust jigs with three cells 4 by 7-ft. The washed coal from the jigs goes to dewatering screens with ¼-in. perforations, the oversize being crushed to ¼-in. before going to the ovens, the undersize goes to the fine coal elevator boots and thence to the Elmore drier. The draw-off from the first and second cells and also the hutch from the first cell goes to the waste direct. The draw-off from the third cell is screened over a ¼-in. screen, and the oversize washed in a one cell jig to produce a pea coal with 18 percent ash which goes to the commercial trade. The screenings from the third cell draw-off together with the hutch from the second and third cells of the primary jigs and the hutch from the secondary jig goes to the primary tables and the middlings from the primary tables are again washed on secondary tables.

On the secondary tables another middling product is made for boiler use, this running about 20 percent ash, also the middling next to the tailings end of the table is run in closed circuit.

The capacity of the jigs is from 65 tons per hour on a 13 percent ash washed coal to 45 tons per hour when washing to 10 to 11 percent ash.

The operating results on the jigs are as follows:

| | PERCENT ASH | | |
|---|---|---|---|
| | No. 1 Cell | No. 2 Cell | No. 3 Cell |
| Washed coal | 15.0 | 13.0 | 11.0 |
| Draw off | 65.0 | 55.0 | 27.0 |
| Hutch | 60.0 | 50.0 | 23.0 |

The feed to the tables averages 27 percent ash with 60 percent of recoverable coal, while the tables had a capacity of six tons per hour on the raw coal. This is reduced to four tons per hour when working on the middling product due to the concentration of the bone. On the middling tables this capacity is further reduced to three tons per hour.

The primary tables deliver a washed coal of 11 percent ash, a middling with 25 percent ash and 50 percent of recoverable coal and a clean refuse with 65 percent ash.

On the middling tables the washed coal runs 15 percent ash, the boiler coal 20 percent ash, the recirculated middling 30 percent ash and the refuse 45 percent ash. These tables are working on a concentration of the bone in the coal with a very slight difference in the specific gravity and it is only by taking out the boiler coal and recirculating the middlings that we have been able to make an efficient separation.

As regards the efficiency of the system the drawing off of the middling product clouds the true efficiency of the plant, but when operating without making any middlings but crushing the third cell drawoff from the jigs and sending it to the tables, we have averaged 49 to 50 percent ash in the tailings, or a loss of from 7.5 to 10 percent of coal in the refuse. When operating with the middlings taken out we have averaged 57 to 58 percent ash in the tailings, and have gone up to 60 percent ash during some months. These figures are to be compared with the theoretically possible figure of 53 percent ash when making a 12 percent ash washed coal.

This flow sheet may seem to be unnecessarily complicated and to have too much retreatment involved, but experience has shown it to be absolutely necessary on this particular coal due to the large amount (*Continued on page* 443)

* General Outside Superintendent, Stag Canon Branch, Phelps-Dodge Corporation, Dawson, N. Mex.

# CLEANING COAL AT THE COLONIAL BREAKER, MADEIRA, HILL & CO.

*Improved Preparation Necessitated By Competition—Early Methods Cited—Mine Water Neutralized With Lime—Sand Flotation Process Now Used—Its Installation And Operating Costs Lower Than Jig Equipment*

By W. H. LESSER *

THE recent advances made in the preparation of anthracite coal have been so marked that it is quite interesting to consider for a moment the conditions which have made such improvements so insistent. Competition for the public's light, heat and power business by electricity, oil, gas, bituminous and anthracite coal has forced the anthracite coal mining industry to seek improved methods of preparation capable of serving a critical public with a better quality of product, and at lower costs, if possible. Local conditions such as an enforced high labor cost, discriminating taxation, difficult mining conditions and political interference have imposed upon the industry an operating cost which the industry is making every effort to offset with improvements and betterments. Recent developments in the preparation of anthracite coal have given to the industry a coal cleaning system capable of meeting to a certain extent the above two general requirements, namely, a better quality of coal and a lower operating cost.

A great difference exists between the methods of preparation when coal was first marketed and those of the present time. In the early days only the best and thickest beds of coal were mined, the impurities were hand-picked, and all the material which passed through a ¾-in. square mesh was discarded and sent to the refuse bank. Today, dirty and thin beds of coal are mined and a market exists for all the coal that does not pass through a 1/16-in. round mesh. A limited demand exists for coal passing through a 1/16-in. round mesh. Most breakers of today are equipped with jigs, each with a capacity of say 8 to 10 tons per hour. As you all know, water is used in these jigs, and the separation is made due to the difference in gravity between the coal and slate. For the most efficient jigging practice, coal of approximate similar fracture should be fed into the jigs, and it should be sized as uniformly as possible.

In the sand flotation process, a method of cleaning the coal is offered in which the individual units may have a capacity as high as 1,000 tons in eight hours. By means of this process it is possible to clean the coal, regardless of fracture and size (within certain limits), since each unit handles coal from broken size (through 4 7/16-in. round and over 3 7/16-in. round) down to and including Barley coal (through 3/16-in. round and over 3/32-in. round).

The question of the relative merits of the sand flotation process and the other systems of preparing coal, came up for consideration when Madeira, Hill & Company decided to consolidate their Greenough and Natalie Collieries. Each colliery had a breaker, not modern by any means, but equipped with jigs of the latest design. Preparation costs were high and a critical public were rightfully demanding coal of better quality. The decision to use the sand flotation process in the contemplated new breaker was reached after a thorough investigation and tests were made of it.

Colonial Colliery, consisting of a consolidation of Greenough and Natalie Collieries, is located near Mt. Carmel, Pa., in Northumberland County. It is served by two railroads, the Pennsylvania and the Philadelphia & Reading. Figure 1 shows the general scheme of the consolidation. Rock tunnels were driven from each of the old collieries to the new Colonial shaft which has four and one-half compartments. Four are used for hoisting coal while the other one is used for pipe lines, power cables and signal systems.

*W. H. Lesser*

Two electric hoists, equipped with the usual protective devices, handle the output of the shafts. Up to the present time a total of 1,160 coal cars and 110 rock cars have been hoisted up the two shafts during an 8-hour shift.

This colliery, like all the other anthracite collieries of Madeira, Hill & Company, is completely electrified. The Pennsylvania Power and Light Company supplies the plant with power at 66,000 volts. A sub-station and switch house with a capacity of 5,000 kva is required to handle the load. One bank of transformers with a capacity of 3,000 kva furnishes Colonial Colliery with power at 2,300 volts, while another bank of transformers with a capacity of 2,000 kva supplies power at 11,000 volts to Greenough and Natalie mines. A 500 kw. automatic motor generator set located near the top of the shaft furnishes the necessary power to the inside haulage system containing both trolley and battery locomotives.

The buildings and breaker, Figure 2, were built of a fire-proof construction; steel, mitco flooring, gyp steel roofing and transite siding being used in the construction of the breaker. Important figures concerning the breaker are as follows:

Weight of steel, excluding head frame, 1,022 tons.

Volume of structure, 882,020 cu. ft.

Designed capacity of the breaker in eight hours, 2,500 tons.

The operating experience obtained since the plant has been built, indicates that it will clean 3,500 tons in eight hours without any difficulty whatever.

A group drive has been adopted in selecting the motors required to drive the machinery. Slip ring 2,200-volt induction motors with a speed reduction through silent chain drives furnish the driving power. Their control panels are located in a central control room. Including the four sand pumps, a total of 1,200 h. p. is required to operate the breaker. Ease in operation is obtained by the use of 14 direct current magnetic clutches distributed among the feeders, picking tables, cone drives and boom loaders.

As many of you know, the sand flotation process of separating the slate from the coal is one in which the raw coal is discharged into a mixture of sand and water with a density of 1.75. An agitation of the sand and water both hydraulically and mechanically keeps the sand in suspension and forms what is called the fluid mass. The equipment required in the system consists of a separating tank designed to hold the fluid mass; desanding shakers for removing the sand and water from the washed coal and refuse; a common reservoir for collecting the sand and water coming from the desanding shakers, and a pumping system for returning the sand and water to the separating tank.

A detail of the apparatus above outlined, and as used in the Colonial Breaker, is shown in figure 3. We have four type F cones 13 ft. 6 in. in diameter. Each cone consists of a conical shaped separating tank, a classifier column, refuse chamber and top and bottom slate gates. Attached to the upper part of the separating tank are the sand pump return and the overflow apron. The object of the classifier column is to remove most of the sand from the slate on its descent into the refuse chamber. This is accomplished by means of the upward velocity of the water introduced into the classifier column for the agitation of the fluid mass in the separating tank. The agitation obtained by the use of water is assisted by a slowly revolving mechanical agitator driven through a set of bevel gears. Additional agitation may be obtained by water discharged into the separating tank through jets connected to the side of the cone.

* Mechanical Superintendent, Madeira, Hill & Co.'s Anthracite Interests, Frackville, Pa.

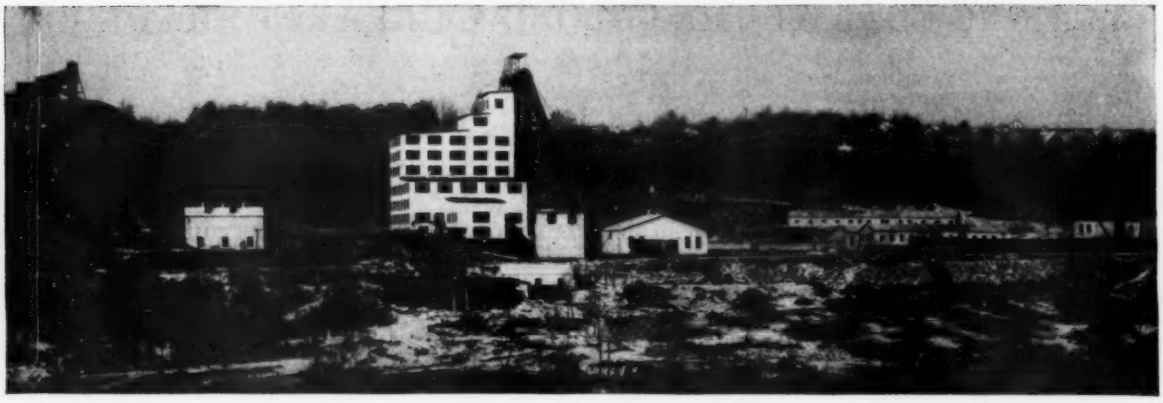

*Figure 2—The Colonial Breaker of Madeira, Hill & Company, Natalie, Pa.*

Below the classifier column is the refuse chamber with a slide valve on its top and bottom. Compressed air cylinders, interlocked so that both are not open at the same time, operate the slate gates. The slate from the refuse chamber is discharged into a water-sealed refuse conveyor from which it is delivered to the slate desanding shakers.

A body of nearly clear water is maintained above the fluid mass in the separating tank which aids the removal of sand from the coal on its way to the desanding shakers.

The general scheme of preparation adopted in the Colonial breaker and the application of the sand flotation process to it is shown in figure 4. The mine cars are hoisted on self-dumping cages to the top of the breaker and their contents dumped into a dump chute capable of

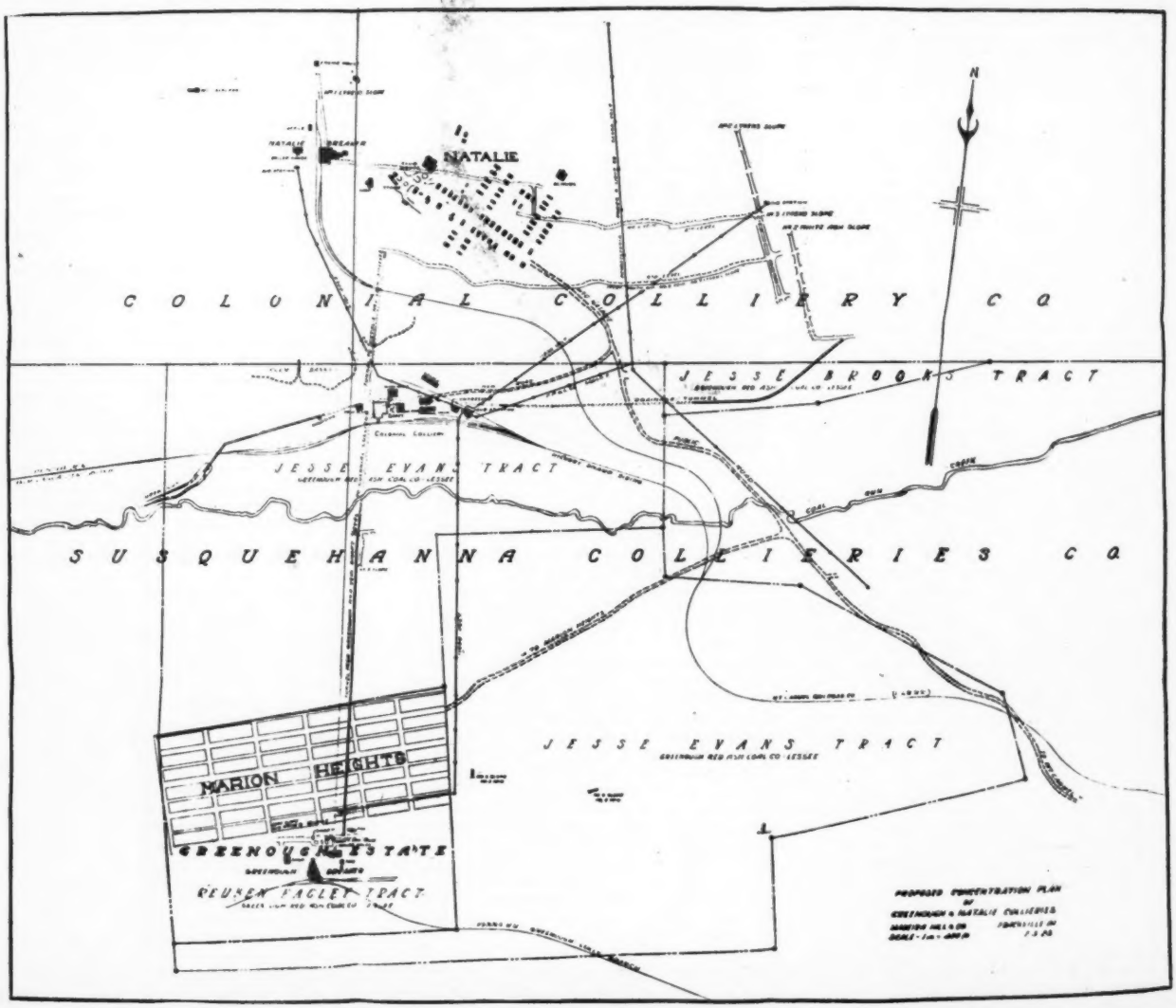


*Figure 1*

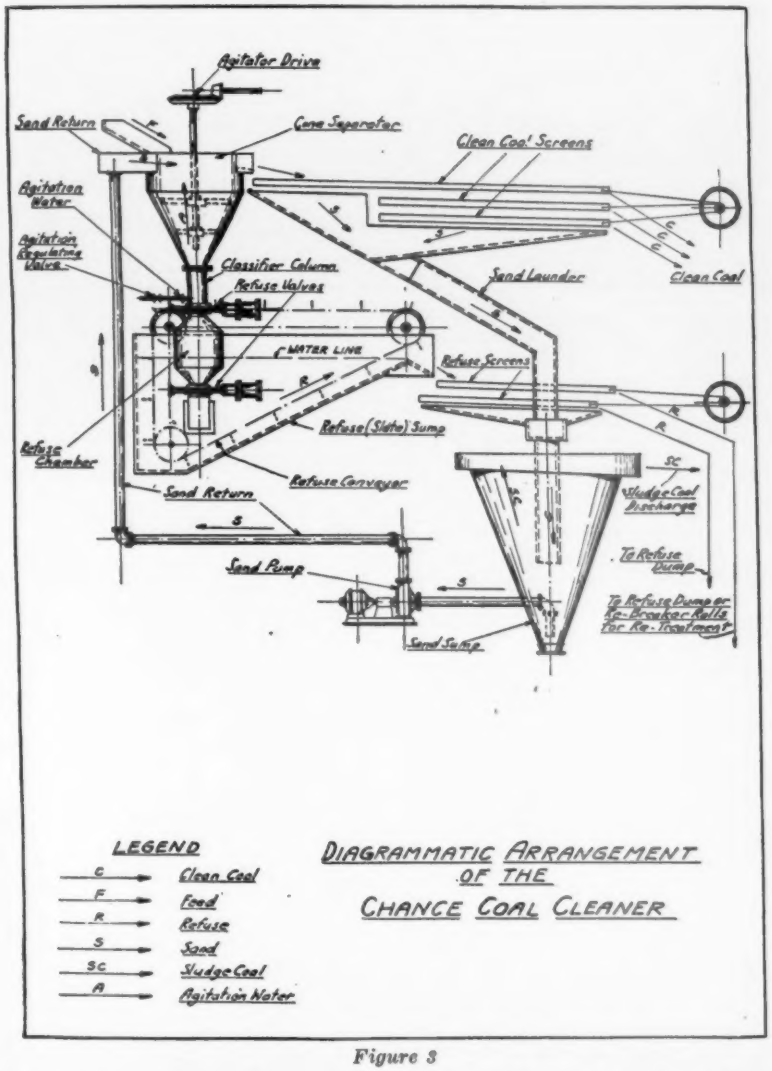


*Figure 3*

holding eight cars. Two fly gates in the bottom of the dump chute, operated by electric hoists, make it possible to by-pass the tunnel rock from the coal stream into a rock bin. From this bin the rock is fed by a mechanical feeder, controlled by a magnetic clutch, upon a shaking picking table where stray pieces of coal are picked from it. The rock then passes into the large refuse hopper from which it is loaded into the rock larry.

Two magnetically clutched feeders feed the run of mine coal from the dump chute to the bull shakers which are equipped with 6-in. round segments. After this it passes over a picking table, where the slate is picked from it by men before it is crushed to steamboat size and smaller by a pair of No. 1 or crusher rolls. Directly underneath the bull shaker is a steamboat shaker, where steamboat is made over and broken and smaller passes through. This stream of steamboat after having the slate picked from it by hand intermingles with the stream coming from the No. 1 or crusher rolls. After the under size is screened from it on a steamboat shaker, the steamboat passes through the No. 2 rolls where it is crushed to merchantable sizes (broken and smaller). We now have the entire run of mine reduced to broken coal and smaller, and it is gathered together into a large receiving hopper from which it is fed by two magnetically clutched feeders as two separate streams. These streams remain separate from this point until they are discharged into the railroad cars, thereby making it possible to operate one-half of the breaker while the other half is shut down due to an accident, insufficient force at work, or semi-holidays. Each stream of coal now passes over the raw coal shakers which divide it into pea and smaller, and chestnut and larger. One cone handles the larger product and the other the smaller product. An arrangement of this kind permits the density of the fluid mass in the cones to be regulated to suit the two sizes of coal. Chutes are provided before the cones, which enable us to mix the sizes or to operate only one cone when necessary. The barley coal (through 3/16 in. and over 3/32 in. or 1/16 in.) which is made on the raw coal shakers, may be either passed through the cones or to the pockets without cleaning. Bowl classifiers and Dorr rakes make the No. 4 and No. 5 barley. The overflow from this equipment and from the sprays in the breaker flows to a Dorr thickener with a steel tank 90 ft. 0 in. in diameter, where the water is clarified and returned to the breaker circulating system.

After the coal is desanded it passes over the clean coal shakers—the sizes nut and over are loaded directly into the railroad cars by loading booms. Pea and the smaller sizes are passed into pockets from which they are loaded by a single belt conveyor into the cars.

When no sale for broken exists, it is broken to egg coal by a pair of rolls provided for that purpose. Sizes smaller than pea coal and the breakage produced on the domestic coal shakers are returned to the flow of coal by means of a conveyor called the chipping line.

The slate, after being desanded, is discharged into a slate conveyor line which carries it to the large rock bin mentioned previously.

An 8-in. manganese steel-lined centrifugal pump is necessary for each cone for circulating the sand and water. We have installed two additional pumps, as they facilitate the making of repairs, in that it is possible to do this work during the day time when no overtime is incurred. The cost of repairs to the pumping system and also the general breaker machinery have been reduced to a minimum, due to the fact that we neutralize the acidulous mine water with lime before it is used.

Coming now to the results which may be obtained if the sand floatation process is applied to the preparation of anthracite coal, we have found that in our plant, the important cost elements, namely; initial investment and operating costs have been lowered. We are of the opinion that the Colonial Breaker was built for 70 percent of the cost of a similarly constructed breaker equipped with jigs. The operating costs are approximately 15 cents per ton less than those obtained in our own jig equipped breakers. In connection with operating costs, one is justified in concluding that the cutting action of the sand on the pipe and steel cones would be responsible for a high maintenance cost. Still in the face of such conditions, a lower preparation cost is attained.

The cost of the sand used is a new item entering into operating costs. Under the conditions existing at Colonial Colliery today, the sand costs us 1.25 cents per ton shipped and we consume 12.5 pounds of sand per ton shipped. When the breaker was first started, the sand consumption was higher than the figure just mentioned; we are, however, conservative when we say that a consumption of 15 pounds of sand per ton shipped can be easily maintained.

Before making any statement as to the quality of the coal shipped from the breaker, you should know that ten different beds of coal are mined from the Lykens to Orchard inclusive. The coal as mined varies in density, fracture and inherent ash. Specific gravity determinations show that pieces of coal vary in density from a low of 1.466 to a high of 1.706. Likewise, the refuse varies in density from a low of 1.897 to a high of 2.607.

The inspections of thousands of cars of domestic size coal shipped from the breaker, show a range of refuse from zero to 1.5 percent, while the smaller sizes vary in ash from 8 to 15 percent.

When producing coal of the above grade, the coal in the refuse bank will average 1.61 percent of coal, 1.92 percent of chipped coal and 2.25 percent of bone. By chipped coal is meant those pieces of coal which have been chipped from a piece of slate.

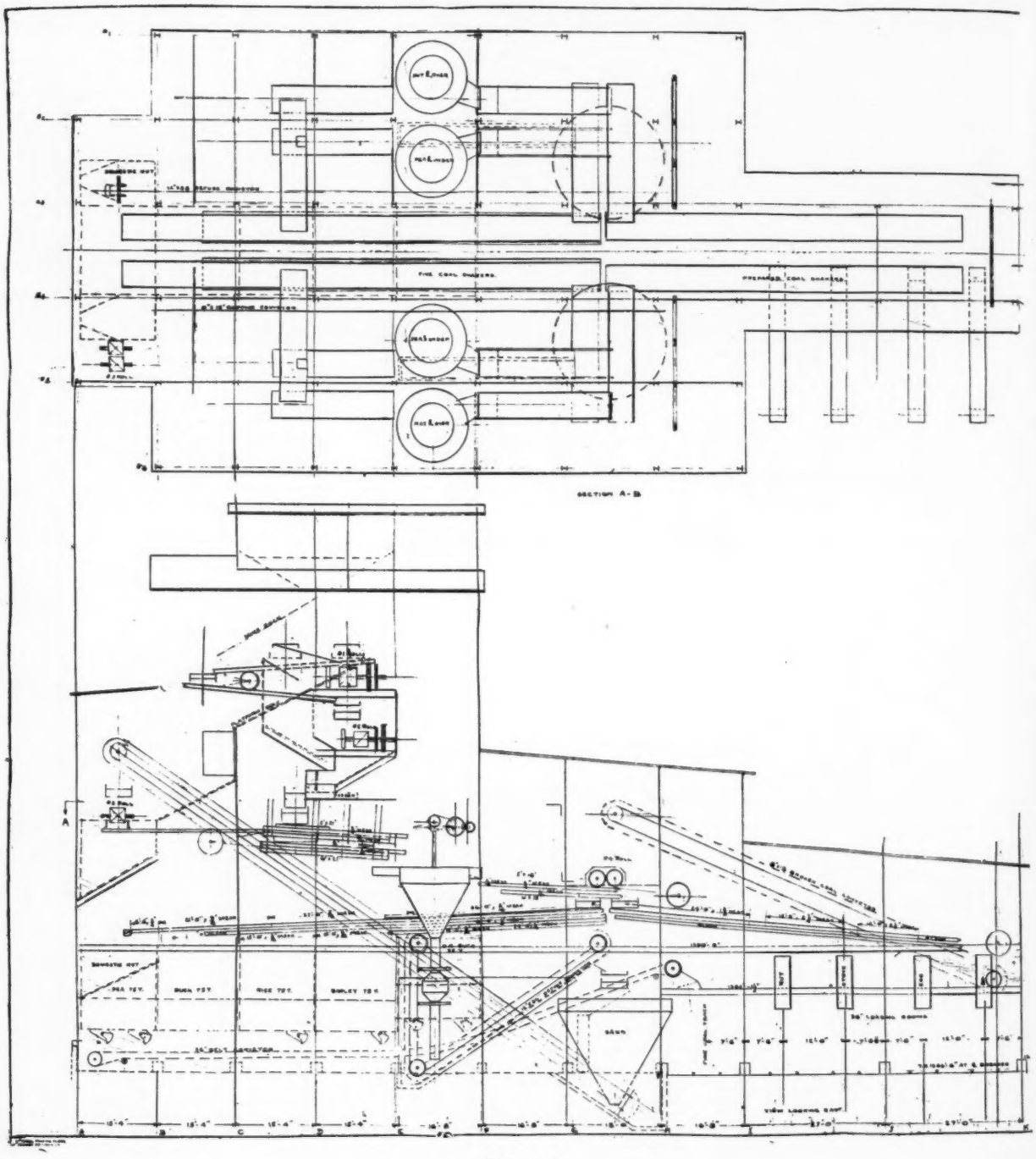

*Figure 4*

A small amount of refuse is shipped with the coal, but the important fact about this refuse is—it is a refuse with a high carbon content. Also that coal lost with the refuse is coal with a low carbon content. Results such as these, require close and efficient supervision, ample shaker area, proper desanding facilities and water of sufficient quantity and clarity.

Our experience up to the present time indicates an increase of 3½ percent in the prepared sizes over that obtained in the old breakers. This entire improvement can not be credited to the sand flotation process as the elimination of storage pockets, the use of coal loading booms and belt loaders have also helped.

The mine car yield per car dumped shows a loss of 1/10 of a ton, due to the reduction in the amount of refuse shipped to market which is, however, offset by the gain in prepared sizes attained through less breakage. Considering the above two factors, the value of the contents of a mine car shows a slight increase over that which existed previous to the consolidation.

Our sales department reports an increasing demand for coal cleaned by the process, the customers are pleased with it, and premium prices are being obtained for the domestic sizes.

Due to the industry's desire to serve the public with a better and better quality of coal, there is a lively discussion among mine managers in the anthracite field as to the relative merits of the sand flotation process, the launder system or the jig method of preparation. In view of the product produced and the operating experience which we have obtained with this process, I feel safe in saying that if our management was required to make a prompt decision re-

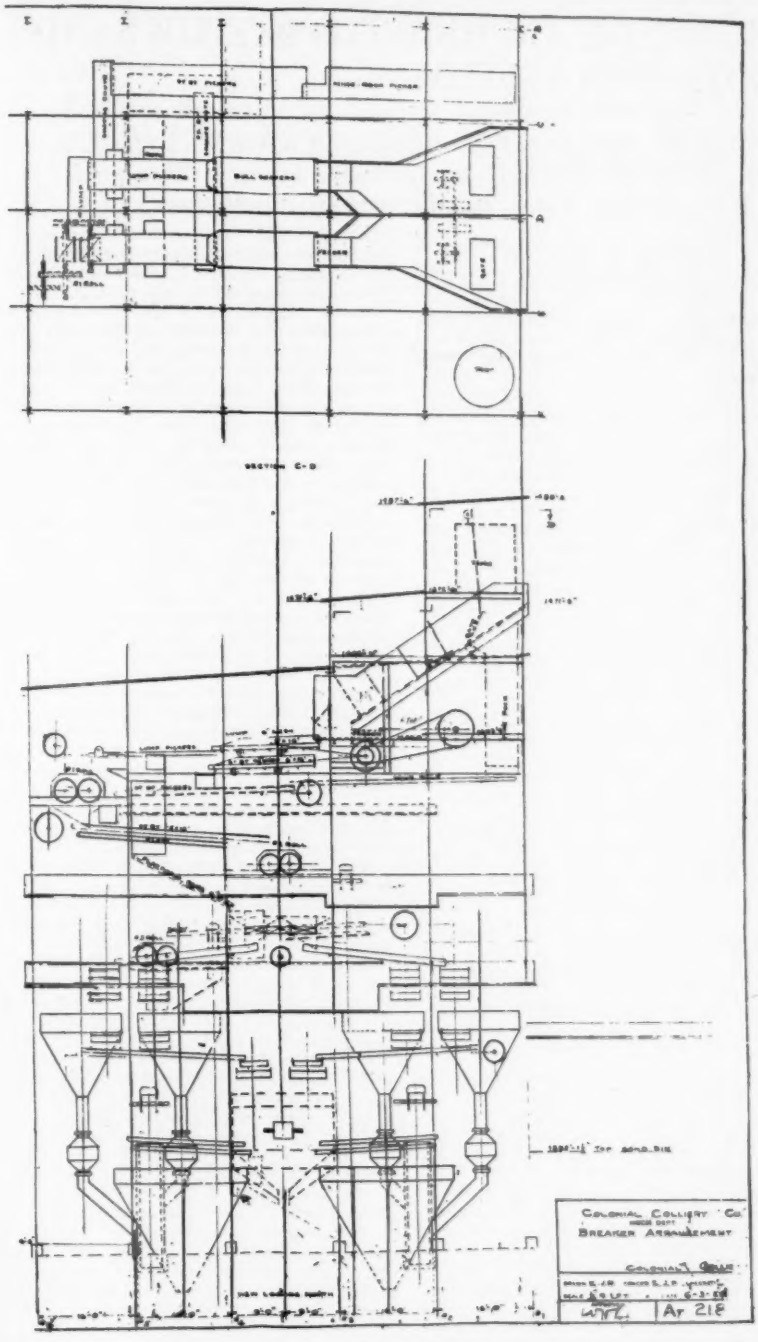


*Figure 4*

garding which system was to be used in a new breaker, they would decide upon the sand flotation process with either the launder, the hydrotator, or the table concentrating system for treating the barley size and smaller, that is, all the sizes passing through a 3/16-in. round mesh.

During the discussion following Mr. Lesser's remarks it was brought out that in the application of sand flotation process to bituminous and anthracite coals the only difference is in the application and the design of the accessories, the same principle being used all the way through. In response to an inquiry concerning the gravity carrier, Mr. Lesser said:

"The gravity of our sand in the separation tank (sand and water) varies from 1.7 to 1.75. The density of the coal getting into this breaker varies from 1.46 to 1.7, and the density of the rock at Colonial colliery varies from 1.9 to 2.6. We have quite a variation in the gravity of the coal and quite a variation in the gravity of the rock. I understand some of the other sand flotation processes carry a higher gravity."

It was brought out that very little sand gets out with the coal, and that in large domestic sizes there is absolutely no sand that gets away with the coal. Mr. Lesser said that their ash run in barley coal is about 18 percent.

## DISTRIBUTION OF ASH-FORMING CONSTITUENTS IN COAL

The ash-forming constituents of coal may be roughly classified as inherent impurities and extraneous impurities, state W. A. Selvig, chief chemist, Bureau of Mines, and W. L. Gardner, research fellow, Carnegie Institute of Technology, in a recently issued bulletin. The former are mixed more or less intimately with the coal substances, and are derived either from the original coal-forming material or from external sources such as sedimentation and precipitation while the vegetal coal-forming plant remains accumulated. The latter are present in the coal bed as partings, bands, or nodules of pyrite, slate, shale, calcite, bone, etc. These are formed either during the laying down of the coal bed or subsequently. Fragments of roof and floor which became mechanically mixed with the coal in the process of mining also contribute to the extraneous impurities.

By carefully buring a lump of coal in a muffle furnace an ash skeleton may be obtained which, if examined, will usually show that the mineral matter is not uniformly distributed through the coal mass. Investigation of a number of British coals has shown that this matter is not uniformly distributed throughout the coal mass; also that coal may break up on handling or crushing into fragments which differ considerably in percentage and composition of ash.

Inherent impurities which consist principally of siliceous and argillaceous material have a high fusing temperature; but if they also contain considerable quantities of calcite, gypsum, or pyrite they are likely to have a low fusing temperature, as the ash then contains well-mixed and finely divided constituents which readily combine to form a low melting slag.

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The Department of Mining Engineering of the University of Illinois has started an investigation into the general subject of accidents due to falls of roof and coal.

Most of the field work will be done by Prof. I. M. Marshall, of the Mining Department of the university, who brings to the study of this problem not only coal experience but also a wide experience in metal mining. "It is hoped that the results of this investigation will be of value as well as interest to the mining industry in general and to the Illinois operators and miners in particular," states A. C. Callen, professor of mining engineering.

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The Yolande Coal & Coke Co. is sinking a shaft into the bituminous coal stratum at Connellsville, Ala., near the Jefferson County line, the cost to be in the neighborhood of $500,000.

# COMMERCIAL PREPARATION OF ANTHRACITE BY THE SAND FLOTATION SYSTEM

***Developments In Coal Cleaning Systems In Anthracite Field Outlined—Chance Sand Flotation System Fully Described And Results Obtained Generally In Anthracite Industry Through Its Use Presented—Data Based On Contact With Sixty Percent Of Installations***

*By* CHARLES DORRANCE*

UNTIL about 1921 only two mediums had been commercially used in the mechanical elimination of impurities from anthracite; namely, air and water.

The inefficiency of air as a separating medium is evidenced by the condition found in rewashing of the culm banks and is a well-known fact to operators who have used it, either in the slot or friction type of mechanical slate pickers. Generally speaking, since 1915 air has been discarded as a separating medium except as an aid to hand sorting in sizes above egg coal.

The use of water as a separating medium started in the southern anthracite region during the decade 1870-1880 with the introduction of jigs. Their adoption in the northern field was slower and it was not until 1915-1918 that jigging generally replaced mechanical separation in the Lackawanna and Wyoming fields. The reasons for this slower change in the northern region were (1) a run of mine product hand loaded, relatively free from impurities, causing less comparative loss to the culm bank; (2) the increased capital and maintenance charge for jigs than for mechanical separators; and (3) the pressure exerted by the sales agents of the northern field against a wet product as compared with a dry one.

About 1921 two systems of separation, each based on flotation, were brought to our attention in the northern anthracite region; namely, the Chance and the Conklin. Their fundamental difference was that the Chance floated off the coal on a fluid mass of sand or other similar material, preferably between 30 to 80 mesh in size, and water, the sand being kept in mechanical suspension through agitation. The Conklin proposed to float the coal on the surface of a slime made by a mixture of extremely fine sand or other material, preferably through 200-mesh in size, held in suspension without agitation.

Experiments were conducted on both systems. The Conklin installation made an almost perfect separation on sizes above a ⅜-in., the coal bobbing across the surface of the tank, the slate sinking. Its defects were (1) the difficulty of maintaining complete and uniform suspension for a period of a work day; (2) the extreme difficulty and heavy capital charge to provide settling capacity for recovery of the fine slime washed from coal and slate; and (3) the cost of suitable fine material for the make up necessary for the process. For these major reasons we consider it the less desirable of the two.

While the Chance system presented some mechanical difficulties, we felt it was capable of commercial results and proceeded to install it at a colliery producing about 1,200 tons daily. With this installation we also made the first anthracite installation of loading booms and elimination of loading pockets for sizes larger than buckwheat. Since 1921 there have been 24 breakers in the anthracite region wholly or partially equipped with the Chance system, and a very large majority of all new breakers built have adopted it.

It is not the purpose of this paper to describe the apparatus nor discuss the method of operation. It seems necessary only to point out that fundamentally the principle on which it is based, namely, a separating medium of such specific gravity as to differentiate between the lighter coal and bone and the heavier sulphur, slate, and rock, is sound and technically correct. Such a medium, if properly maintained, must be best adapted to prepare efficiently for market the average run of mine product produced in the anthracite region today, with its extreme fluctuations in impurity content and fracture, with a minimum of pre-preparation sizing.

The purpose of this paper is to present, from a practical operating standpoint, the results which have been obtained generally in anthracite preparation with the Chance system. The opinions and figures given are based on inspection, operation, or professional contact with about 60 percent of all the Chance anthracite installations.

### CAPITAL COST

The cost of a modern breaker using the sand flotation system is from 60 to 75 percent of a jig breaker of equal capacity, the design being the same in each case except as to actual preparation facilities.

### OPERATING COSTS

The actual labor of operation properly chargeable to preparation with a breaker using sand flotation is approximately 50 percent of the same cost in a modern jig breaker of the same separating capacity. Although the Chance system lends itself more readily to loading-boom installation than does a jig breaker, I do not consider it fair to credit the large loading decrease in cost consequent to loading booms to the flotation system.

Independent of the fact that the wear on machinery, pumps, etc., by the sand is heavy, the total maintenance charge, both labor and material, with the sand flotation system is approximately 50 percent of the maintenance with a jig breaker of like capacity.

There is little if any difference in the power cost for mechanical drive and pumping as between flotation and jig systems of same capacity.

The total operating and maintenance cost, material and labor, with a modern breaker using flotation system is about 75 percent of a modern jig breaker both using loading booms. This comparison includes the average royalty and sand cost of the flotation.

### YIELD

While the yield of prepared sizes per cubic unit of run of mine in many of the Chance installations has shown a marked increase as compared with the former jig installations which they have supplanted, I am not prepared to say that, given the same conditions as to quality of run of mine, the sand flotation system will produce a greater prepared yield than a modern jig breaker, both being equipped with loading booms. While the flotation process produces a less breakage of the prepared sizes than the jigs, this is at least partially offset by the fact that actually the coal coming from the jigs under normal market conditions contains about 2 percent more slate than does the coal coming from the Chance cones. Because of the great variations in run of mine, mine car topping, etc., it is extremely difficult or impossible to get comparative figures, but my opinion would be that notwithstanding the decreased tonnage of slate in the market product the prepared yield under like conditions will be fully equal if not greater with the flotation system compared to modern efficient jig practice. Under competitive market conditions when the jigs must be forced to reduce the slate content in market coal, there is no question in my mind, with the ensuing bad slate ends of the jig consequent to close jigging, that the sand flotation will produce under like conditions a greater prepared yield.

The losses of coal in the culm bank may be properly commented on under yield. No system of preparation can make a separation which will commercially recover all of the combustible contained in the run of mine product. The material in sizes nut and larger where bands of sulphur or caps of slate adhere to pure coal have sufficient specific gravity as a whole to sink with the slate. My figures show that the loss of commercially pure coal with a sand flotation system is about 50 percent less than with a jig system with like conditions as to run of mine and market competition. The sand flotation further affords a much better and safer opportunity to break down the refuse in the larger sizes for retreatment to save the commercial coal in the sulphur streaked, slate capped and boney material than is the case with jigs. In neither system is this advisable unless a frequent inspection is made on the product going to the rolls.

### MARKET PRODUCT

Under similar conditions as to run of mine and with a properly cleaned slate end, the sand flotation system, with reasonably efficient design and operation, will give a better and more uniform quality of market product in prepared sizes than any existing system. It practically eliminates all heavy slate or rock, these being the main cause of trouble in the domestic use of anthracite. The lighter slate or bad bone will average, depending on the run of mine treated and the size of coal, from 1/5 to ½ the amount allowable under the present standards. Aside from questions of improper sizing or too great a light bone content in run of mine, sand flotation will eliminate condemned coal in the prepared sizes. Neither (*Continued on page* 434)

* Consulting Engineer, Scranton, Pa.

# CLEANING OF SMALL SIZE BITUMINOUS COALS

*Problem More Difficult Than In Cleaning Large Sizes—Any Method For Cleaning Fine Bituminous Coal Must Be Mechanical, Because Hand Picking Is Not Possible—The Froth Flotation Process Described*

By LOUIS W. HUBER *

FOR the purpose of differentiating between ordinary coal cleaning processes and processes for cleaning fine coal I have assumed fine coal to be that which will pass through a ¼-in. screen. The amount of this coal produced in the mining operation varies considerably, according to how the coal is mined and handled. In 2-in. round hole slack screenings there is from 15 to 20 percent ¼-in.-0 coal. The average mine produces minus 2-in. slack in the amount of from 35 to 60 percent of the average total output. This means, then, that ¼-in-0 coal comprises from 5 to 18 percent of the total mine production. The treatment of this size coal presents a much more difficult problem than the treatment of larger coal. We get fine sized bituminous coal in the regular screening operation; that is, when we are screening for lump coal production, and screen out the slack. Of course, that fine coal is produced in the mining operation. We also get it when we crush coal for coking purposes, and we sometimes make fine coal deliberately so as to liberate the ash-forming constituents and make more thorough cleaning possible.

* Assistant Professor of Mining, Carnegie Institute of Technology, Pittsburgh, Pa.

Fig. 1 shows the effect of crushing on washability. Curve A of Fig. 1 is the washability curve of a coal crushed to pass a ¼-in. screen. It will be noted that this curve is almost a straight line—indicating that the coal is exceedingly difficult to clean efficiently or economically. Curve B of Fig. 1 is the washability curve for the same coal crushed to pass a ⅛-in. screen. It will be noticed that there is quite a difference in the washability curve and that the finer coal lends itself to washing much more readily than the minus ¼-in. coal. For example, if, on the above coal we attempted to clean after crushing to minus ¼-in. to get a 10 percent ash coal, we couldn't possibly get better than a 46 percent yield. After crushing to minus ⅛-in. it is possible to get a 73 percent yield of 10 percent ash coal.

We are not in a position to talk about cleaning any coal, and particularly this fine coal, until we have tested it for washability. By that I mean the screen test analysis, in which we analyze for the ash in the different sizes. This tells us in what particular sizes most of the ash-forming constituents are, and a float-and-sink test tells us whether the ash-forming constituents are mostly heavy material or whether they are pretty well distributed through both the heavy and the lighter material. Finally, if possible, an actual cleaning test is desirable. In order to make any of these tests it is important, first of all, to get a good representative sample. The importance of getting a representative sample can not be overemphasized, but I will not attempt to describe here how such a sample should be taken. Obviously if a plant were designed and constructed to clean coal on data obtained from tests made on a sample which was not representative of the mine's production, a serious and costly mistake would be made and considerable argument between the mine operator and equipment manufacturer would result.

As regards cleaning methods, any method that is used for cleaning fine bituminous coal must be mechanical, because hand picking is out of the question.

Of the wet processes first is the shaking tables that can be used for the cleaning of fine coal; then there is the launder system, such as is sold by the Rheolaveur Corporation; the Hydrotator System,

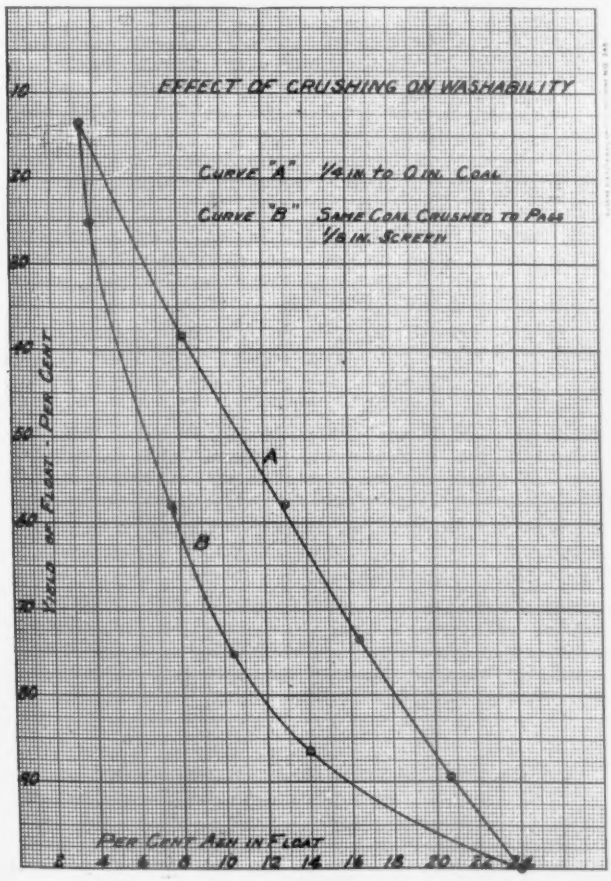
EFFECT OF CRUSHING ON WASHABILITY
CURVE "A" ¼ IN. TO 0 IN. COAL
CURVE "B" SAME COAL CRUSHED TO PASS ⅛ IN. SCREEN
A
B
YIELD OF FLOAT - PER CENT
PER CENT ASH IN FLOAT

*Figure 1*

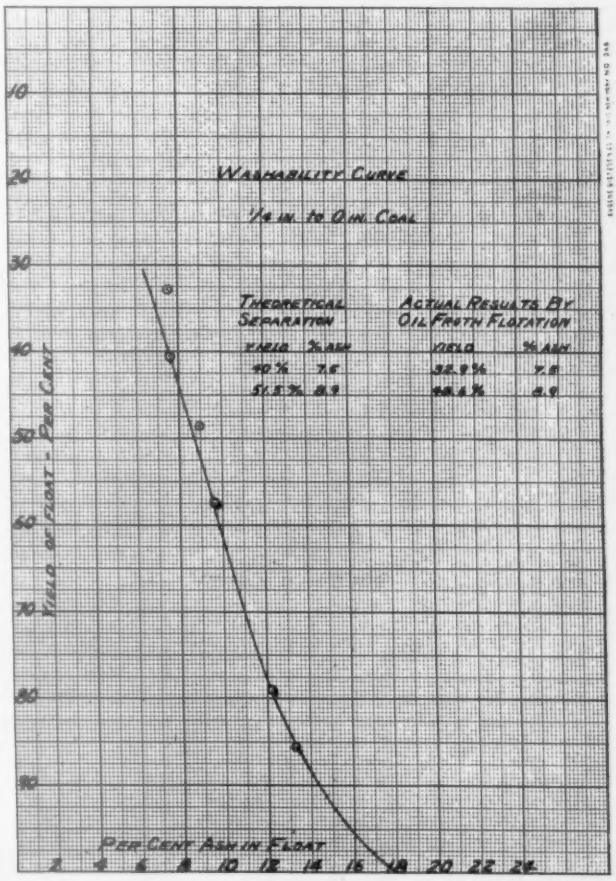


*Figure 2*

which is sold by the Hydrotator Company and is used in several different ways. There is the Trent Amalgamation Process, and, finally, the Froth Flotation process, which I will describe.

In any of the wet processes we, of course, have the wet coal problem, which may or may not be serious, according to the plan of operation. The dry table process for cleaning fine bituminous coal is a very good process if we feed a well-sized product to the table. However, if the coal is wet, we are presented with a screening problem, because we can't screen wet fine coal and screen it closely. If the coal is too dry, we are presented with a dust problem. Of course, the dust problem can be handled. The screening problem can't be solved if the coal is wet unless it is dried beforehand.

Froth flotation consists of using a small amount of oil introduced into a mixture of coal and water, mixing the oil, water and the coal thoroughly and then introducing air in the mixture so that we get rising bubbles of air which cause a strong froth at the top. The coal has an affinity for the oil froth so that it comes up to the top as clean coal. Ash-forming constituents are usually rejected.

One of the advantages of the oil flotation process is that it isn't a gravity process. It doesn't depend on the specific gravity of the coal. The amount of oil used in the oil flotation process amounts to about .2 of 1 percent, or 2 pounds to a ton—roughly speaking, about a pint of oil. Almost any coal or pine tar oil can be used.

There is one misconception, I think, that many people have on oil flotation (due to the fact that froth flotation was first used in ore fields for separating sulphides from gangue), which is that the iron pyrites or iron sulphides would have a stronger affinity for the oil bubbles than the coal, and that this would result in a concentration of sulphur in the froth. That isn't true, because in some of the tests we have made we have been able to get a better reduction of sulphur by froth flotation than by using tables or an upward rising current classifier.

Fig. 2 illustrates a washability curve which was made for a coal from the Eagle seam of West Virginia—a very bony coal—crushed to minus ¼-in. In the left-hand column is indicated the theoretical separation which indicates maximum yields of 40 percent of 7.5 percent ash coal and 51.5 percent of 8.9 percent ash coal. In the right-hand column the actual results obtained by oil froth flotation are indicated. By actual oil froth flotation tests we were able to obtain 32.9 percent of 7.5 percent ash coal and 48.6 percent of 8.9 percent ash coal. Both of these points are plotted on the curve and, as can be readily seen, approach very closely to a perfect separation.

Another thing that it is pertinent to mention here is that, when using any of the gravity processes (i. e., processes which depend on a difference in specific gravity between clean coal and reject) in cleaning coal the separation is much more difficult to make when it is at a low gravity. The first actual washability point on the curve (32.9 percent yield—7.5 percent ash content) indicates an effective specific gravity of separation of about 1.25; the second point (48.6 percent yield—8.9 percent ash content) about 1.35. With any of the gravity processes we could not hope to approach the perfect separation at these low effective gravities anywhere near as close as we do by means of oil froth flotation. I should qualify the above by excluding the Chance sand flotation process and the Fraser-Yancey air sand process, as both of these are direct heavy gravity medium processes which will work (on coarse coal) efficiently at all gravities from 1.0 up to the maximum that can be developed and maintained by each.

Fig. 3 illustrates the Hydrotator machine which can be used as an upward rising current classifier or coal separator, as a thickener for clarifying water or thickening sludges, and as an oil froth flotation machine. The experimental work from which the results given above were obtained was done on the Hydrotator acting as a flotation machine. The only place where power is applied to the unit is on the centrifugal pump. The pump delivers water up in the agitators through a vertical sleeve connection. Water, being forced out the submerged agitator nozzles into the water in the tank, causes the spider (consisting of four rows of inclined nozzles) to rotate the same way as a lawn sprinkler is caused to rotate when water is forced through it. This causes mechanical agitation as well as upward rising current. In using this machine as an oil froth flotation unit flotation oil is allowed to be drawn into the inlet of the pump from an oil cup and air into the same place through a pet cock placed in the inlet pipe. With this arrangement the amounts of air and oil (the important variables in oil froth flotation) are easily changed and regulated.

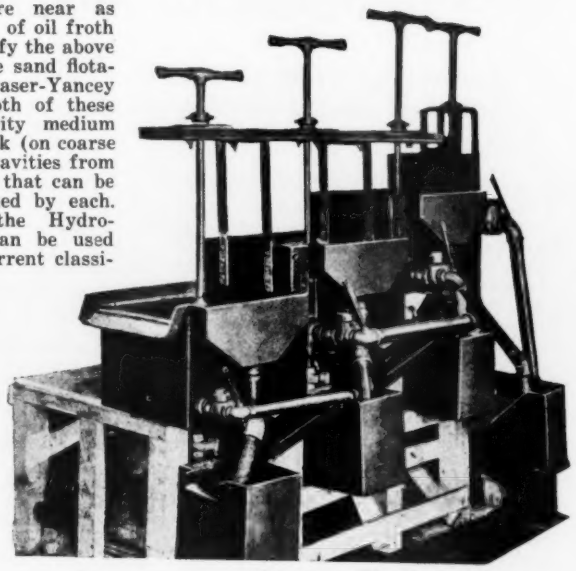

*Figure 3—The Hydrotator*

When the proper amounts of air and oil are allowed to be drawn in through the pump and discharged into the tank containing fine coal and water in constant agitation, a very heavy, thick froth is formed on top of the water. The froth which collects clean coal and rejects high ash constituents can be easily skimmed or raked off. The froth usually contains about 50 percent moisture; this is a distinctly advantageous point as the overflow from jigs or straight upward rising current machines contains usually about 80 percent moisture.

While many coal men frown on oil flotation as a coal-cleaning process, it is my opinion that its advantages as a process for the cleaning of fine coal are so marked that we can not afford to neglect its serious consideration.

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The discussion following Mr. Huber's paper was led by ***MR W. L. REMICK**, The Hydrotator Co., New York City.* Mr. Remick confined his remarks largely to the development of the Hydrotator process, saying:

"About two years ago we began the development of the Hydrotator machine as a froth flotation machine, but little less than a year ago in the anthracite field we began to experiment on the use of the same machine, as simply an upward current classifier. The operation is similar to that in jigging, but the actual jigging principle is subordinated.

"The first operating plant was put into operation about September 15 at the Middle Creek Colliery and Iron Co. The second one was started in operation about two weeks ago and the third will be operating in about two weeks.

"The counter current process involves placing two or more of these units in series. We thought that it also involved removal of the refuse product from the bottom of each stage and returning to the previous stage through the circulating pump—then through the previous stage of classification.

"Just to use the term that Mr. Huber used before, we 'kidded' ourselves into believing that we could combine a water and a solid feed through pipes, pump them through a centrifugal pump and regulate them. But it can not be done. In the first place you have the two different gravities under the same suction and in the second place you can not see what you are doing. Therefore, you can not regulate the feed. The obvious solution of this difficulty was to use a sump and pump from a sump, and that is what we have done with the result that we can regulate the two feeds perfectly.

"Of the two feeds one is the return from the upper portion of each classifier to the pump at the bottom. The other is a return from a refuse product from the bottom of the succeeding classifier through this same pump by the use of an outer sump and that is managed without difficulty whatever. We placed this stage one level below the preceding one and the sumps are also placed in the same series, one lower than the preceding sump.

"Another problem that came up in this design was the segregation of the level of the water—the pulp as we call it in these sumps. It was found that that was not as difficult as we had anticipated. Yet it does cause trouble. If you run your level too light, and use aspirated air in the suction of your pump and in an upward current classifier, that is fatal. In oil flotation it would not be unless it stalled your pump. It is a hard thing to control.

"To overcome this difficulty we put an overflow in each sump and the first stage would overflow (*Continued on page* 436)

# CLEANING ANTHRACITE COAL BY THE LAUNDER SYSTEM

*Modern Preparation Contemplates Nine Sizes Of Product—Competition And The Operation Of Dirtier Seams Demand Standards Of Quality—Installation Has Resulted In 99.82 Percent Clean Coal—Labor Costs And Required Operating Space Reduced 50 Percent*

By SHELBY D. DIMMICK *

THE title of this paper was selected and assigned to me by The American Mining Congress Committee and is slightly misleading as I am not aware of any launder system alone being in commercial operation on coal washing. What I will describe is the Rheolaveur or Current Washing Process of coal cleaning which utilizes launder classification but also adds the separating effects of the Rheo Boxes and the regulating effect resulting from returning a middling or rewash product to the feed.

The preparation or coal cleaning problem in the anthracite industry has assumed considerable proportions with the development of the industry. Today it is comparable to a manufacturing enterprise with all its complexities. Nine different sizes of coal are produced and each size has different specifications as to quality.

As the mining progressed it became necessary to mine thinner and dirtier seams, so that cleaning at the face or in simple tipples or breakers no longer serves.

The recent keener competition from other fuels has intensified the demands for quality products which can be met only by a standardized manufacturing process of high efficiency and great regularity in quality of products.

These conditions must be met and at the same time every effort used to reduce mining and preparation costs so that the price of anthracite coal may be kept as low as possible in the face of rising wage rates.

We may summarize the requirements of the ideal cleaning plant as follows:

(a) High recovery of marketable coal which shall be of the best quality.

(b) Dependable operation with products of uniform quality.

(c) Flexibility and definite control of operation so that all market requirements can be met.

(d) Minimum breakage of coal during preparation as the domestic or larger sizes bring the highest price per ton.

(e) Cleaning equipment of high capacity per unit of volume.

(f) Low first cost of plant.

(g) Low operating costs.

The Rheolaveur System of coal washing which I saw in operation in Europe seemed to me to meet most nearly these ideal requirements and we, therefore, installed Rheolaveur in one of our largest breakers to establish its value. The detailed description of this installation which will be given later will show how well our expectations were fulfilled.

Before proceeding to a description of particular installations, a general description of the Rheolaveur process will be helpful.

The separation effected by this process depends primarily upon differences in specific gravity between coal, bone and refuse. The principles utilized to take advantage of these differences in specific gravity are those of a flowing stream of water in a chute or launder called the "primary classification"; the classification resulting from an upward current of water in some of the Rheo Boxes; and the regulation resulting from returning a middling product high in bone or intermediate gravity material to the feed. Thus the separation on the refuse end is made between refuse and bone and on the coal end is made between bone and coal.

Unlike most gravity cleaning processes, this process does not require a feed which has been screened or classified before introduction to the Rheo launder. The principal size limitation is that the feed must pass a 3½-in. or 4-in. screen, as pieces larger than this are liable to block the Rheo Boxes. The cleaning of coal passing 3½-in. is divided into two steps if perfect washing is required throughout the entire size range.

Figure 1 shows a flow sheet of a complete Rheolaveur plant to clean coal from 3½ in. to 0, consisting of a Sealed Discharge Plant and a Free Discharge Plant in series. The unsized feed coal enters the sealed discharge plant as shown and washed coal, discharged to the sizing screen shown, is clean in size from 3½-in. to 5/16-in. The minus 5/16-in. coal is only partially cleaned and is delivered to the boot of elevator feeding the free discharge plant and retreated in that plant. Washed coal from the free discharge plant is delivered to boot of a washed coal elevator or to sizing screens if the market so requires.

### SEALED DISCHARGE PLANT FOR COARSE COAL

The sealed discharge plant illustrated by Figure 2 provides for crushing bone in the coarser sizes in order to increase the yield and yet maintain a low ash washed coal. The feed entering near the middle of the launder is classified in the stream of water and on arrival at the first Rheo Box has formed a slow-moving bed of refuse on the bottom, a faster moving layer of bone above and the coal at the top moving quite rapidly. The stratification at this box is shown by Figure 3. The refuse is discharged by this box against a rising water current entering the box as shown. This dis-

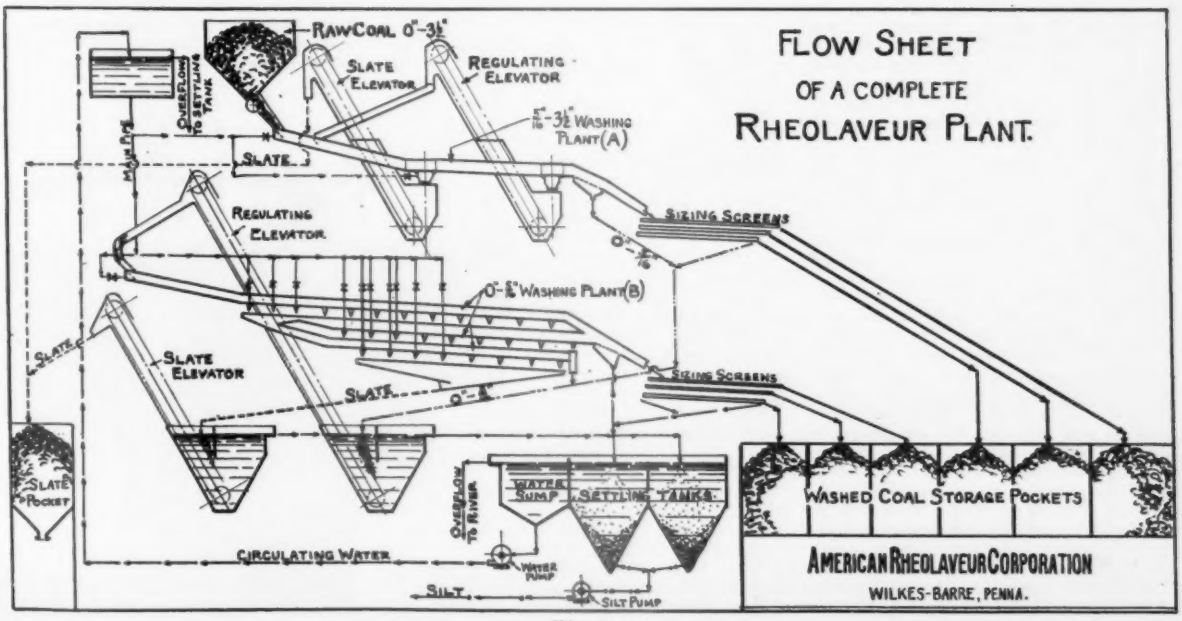



*Figure 1*

* Vice-President and General Manager, Glen Alden Coal Co., Scranton, Pa.

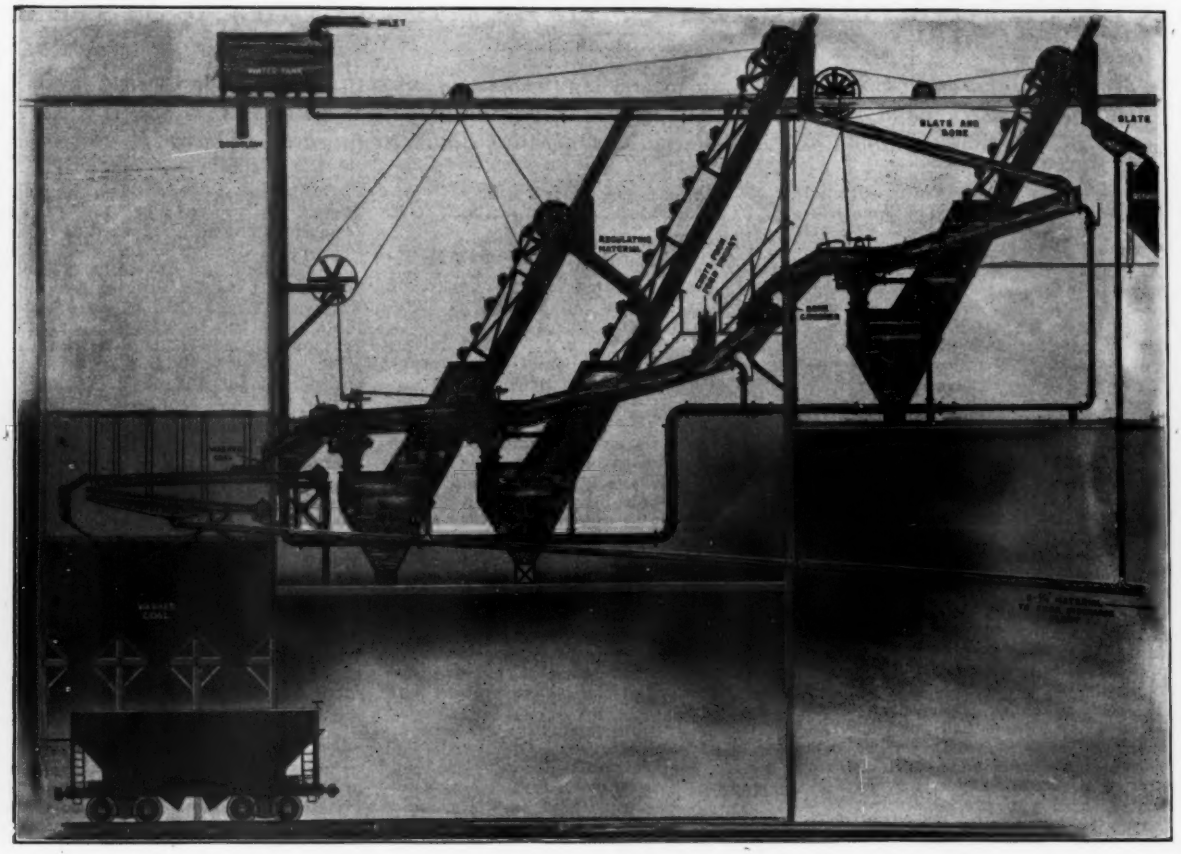



*Fig. 2—Sealed Discharge Plant for Coarse Coal*

charge is controlled by the hand-operated gate and flap gate, and the latter, operating about 60 strokes per minute, prevents blockage. In this case, this box would be so operated as to draw considerable of the bone with the refuse which bone will be recovered by the No. 3 box (Figure 2) to the right as will be described later.

Returning to Figure 2, the coal and some bone pass over No. 1 box and flow along a section of launder of lower pitch to the No. 2 or regulating box which is similar to No. 1 box but is not usually provided with upward water current. Here any refuse and bone which passed over No. 1 box is discharged through the box and only clean coal passes over to sizing shakers or washed coal elevator on its way to railroad car.

It will be noted that all sealed discharge Rheo Boxes deliver to boots of housed elevators which maintain the water level of the launder. These elevators are equipped with perforated buckets so that little water is removed at these points and practically all water introduced passes out with the washed coal.

The discharge from No. 2 box is returned by its elevator to the point of feed and thus returns bone or intermediate gravity material to the feed. This return assists in the separation at the first box as it increases the depth of the bone layer which separates refuse from coal.

The refuse and bone from the first box is delivered by its elevator to the head of the right-hand trough where it is reclassified and the pure refuse discharged through No. 3 box and by No. 3 elevator sent to refuse disposal. The pitch of the classification trough ahead of No. 3 box and upward current used in this box result in washing at a higher gravity than in No. 1 box and the bone floated over No. 3 box is crushed in the rolls and the crushed material joins the feed and is rewashed.

### Free Discharge Plant for Fine Coal

The coal minus 5/16-in. screened from the sealed discharge plant products and recovered in the elevator boot shown on the flow sheet is elevated to the free discharge plant. This plant differs from the sealed discharge plant in that the heavy gravity products passing through the Rheo Boxes fall freely by gravity mixed with water used in washing. As shown in Figure 4, the washing troughs are super-imposed. The primary classification section is at the head end of the top launder and a series of Rheo Boxes attached to the balance of this launder remove the refuse. The details of these boxes are shown by Figure 5, and it will be noted that provision is made for upward current water and control of discharge by use of a disc containing orifices of different diameters.

The boxes on the top launder (Figure 4) drop all the refuse and bone so that the product over the end of this launder is the purest coal. The second launder rewashes the material dropped from the top launder boxes and the product from the end of this launder also goes to washed coal. The third and fourth launders rewash the refuse products dropped by the boxes of the launder next above and the discharge from the ends of these launders is regulating material and is returned to the feed via the feed elevator. The first few boxes

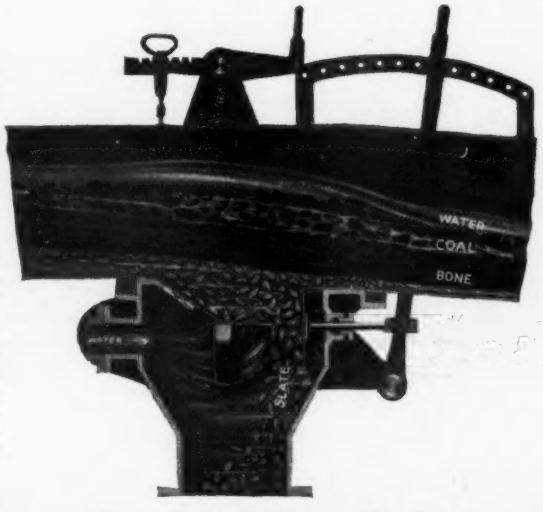



*Fig. 3—Sealed Discharge Rheo Box*

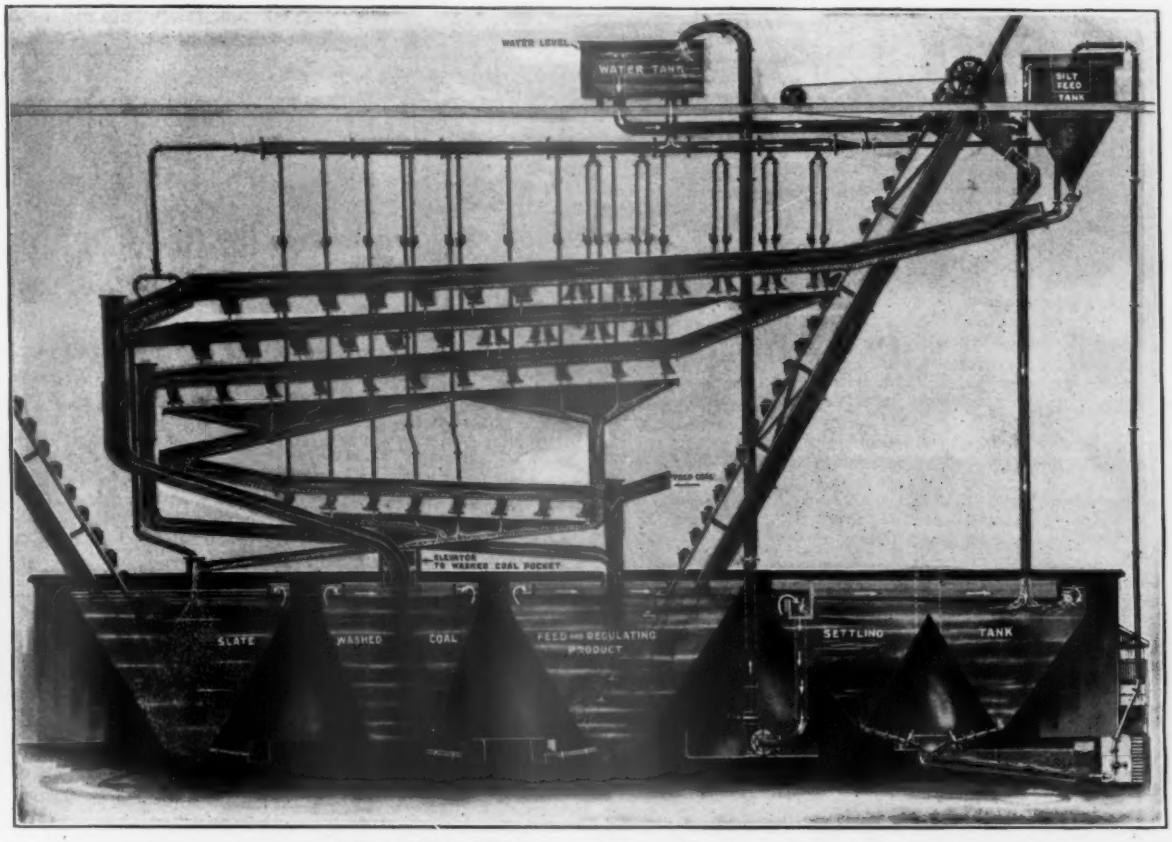



*Fig. 4—Free Discharge Washing Plant for Fine Coal*

on No. 3 launder and all boxes on No. 4 launder discharge final refuse which is delivered to a dewatering elevator or other suitable equipment for disposal.

### Rheolaveur Plants in Operation on Anthracite

Although Rheolaveur has been known to the anthracite industry for only two years, six plants are now in operation. They range from a complete plant to clean 300 tons per hour of minus 3½-in. coal to a silt plant to clean 20 or 25 tons per hour of fine coal passing a 1/16-in. round hole screen. The total annual capacity of these six plants is 2,250,000 tons.

*Fig. 5—Free Discharge Rheo Box*

Two of these plants will be described in some detail as representative. One, the Loomis Colliery installation, is representative of performance on anthracite from the Wyoming Field where the seams are fairly flat and the coal is mined largely by room and pillar method and refuse is gobbed so that the coal to be washed is fairly clean. The other, Hazelton Shaft Breaker of The Lehigh Valley Coal Co., is treating coal from the Lehigh Field where pitch mining is largely done and the entire seam with some top rock, gravel, sand and clay drawn in from the crop is loaded into the mine car.

### Loomis Rheolaveur Plant

The coal is mined from 10 veins through six shafts and one slope. The breaker has a capacity for 6,000 tons output per 8-hour day, and averages between 5,500 and 6,000 tons per day. A general view of the surface plant and breaker is given in Figure 6.

Rheolaveur equipment was installed to treat half the breaker tonnage and it has been fed with what is known as mud-screen egg and smaller, that is, the coal which passes through a 3 7/16-in. round hole shaker screen. The mine coal larger than 3 7/16-in. is handled in the balance of the breaker. Figure 7 shows how the sealed discharge plant was placed in the breaker.

The Rheolaveur equipment consists of two sealed discharge washing launders, 32 in. wide with three Rheo Boxes on each launder. These launders operate in parallel with common elevators for corresponding boxes on each launder. To insure a perfect refuse product, a rewash launder is provided. The refuse from the two No. 3 boxes on the washing launders is delivered to one 20-in. rewash launder, sealed discharge type, which also is equipped with three boxes.

One free discharge plant was installed, but after the first few days has not been operated as on this particular feed coal the fine coal was cleaned in the sealed discharge plant.

The water supply for Rheo operation is divided into two systems, one for push current flowing in the launders and the other for upward current water in the boxes. By this arrangement no sand or other ingredient is used to increase the specific gravity of the water. Constant head supply tanks are provided for each system. The tank for push current receives water from the Rheo circulating pump or what we term return water. This pump handles water which has already been used in the system and has passed through 3/64-in. screens. The upward current tank is supplied with make-up water and also return water from the circulating pump. The circulating pump delivers 6,000 G.P.M. to the system and about 1,000 G.P.M. of make-up water is added, or approximately 4 tons of water per ton of coal is circulated. This amount of make-up water could be reduced to about 500 G.P.M. if a settling tank or thickener were used to partially clarify the return water.

Although no provisions have been made for clarifying the circulating water, no difficulty has been encountered with the water system. However, the

circulation of minus 3/64-in. solids throws unnecessary wear on the circulating pump. But, this has not been serious as the impeller on this pump has shown a life of six months and its repair cost amounted to only 1.6 mills per ton.

Attention is called to the washing of the refuse which passes through four boxes in series before finally being discharged to waste. As the feed coal contains only 7 to 10 percent of refuse, the washing of refuse through four boxes is done in order to insure a perfectly clean refuse end. The result is a refuse analyzing over 80 percent ash and containing less than 1 percent of coal and bone when tested by hand-picking.

The Rheolaveur installation was put in operation October 13, 1926, and has been operating since without interruption.

During October, 1926, the Rheo output was loaded separately but the tonnage produced was such a large proportion of the total output that it became necessary to put it in the main breaker pockets and mix it with the balance of production.

Figure 9 shows the production from the Rheo from October 13 to 22, 1926. It will be noted that rated capacity was exceeded on the third day of operation. The average output for October was in excess of rated capacity. Since then we have frequently handled in excess of 400 tons per hour, for the entire day.

The quality of coal and refuse produced by the Rheolaveur at Loomis has been most gratifying. Market requirements during the past few months have called for a better quality of coal than ever before and at Loomis this condition has been met with greater ease than at our other breakers. Here we have shown a very satisfactory reduction in market coal condemned for slate or refuse, which condemned coal must be dumped and re-prepared in the breaker until it meets market specifications. Since the Rheolaveur has been in operation, two-thirds of such condemnation has been eliminated so that now with a monthly production of approximately 3,000 railroad cars, only about 10 cars are condemned for slate, or a third of 1 percent.

This improvement in quality of market coal has been accompanied by a corresponding reduction in the coal content of the refuse which is less than 1 percent. The reduction of this coal loss has been most marked in the larger sizes which bring the higher market prices.

The above summarizes the operating results of the Rheolaveur so far as quality of products is concerned when judged by the usual standard of hand-picked tests on coal and refuse. We have also tested the Rheo operation by sink and float tests and ash analyses. The sink and float tests enable a determination of efficiencies of plant operation based on separation at a given specific gravity. Such tests on Loomis coal have shown that 1.65 specific gravity separates coal from bone and refuse, while 1.95 specific gravity separates bone from refuse. However, the quantity of bone in Loomis coal is comparatively low and if all or nearly all the refuse sinking in 1.95 specific gravity is removed a washed coal of excellent quality results.

A summary of such a sink and float test is shown on Table 1. It will be noted that the washed coal contains very little sink and the amount of sink is smallest in the larger sizes and disappears in egg, the largest size. This is advantageous as the market specifications call for this variation in quality, i. e., that the larger sizes shall be the purest. It will be seen that the refuse product contains a very small percentage of float in 1.95 specific gravity and has an average ash of 80.2 percent which is another indication of its very low fuel content. The smallest size, barley and barley No. 2, is the only one which shows a drop in efficiency and this efficiency could be brought in line with the rest were the free discharge plant in operation to clean this size. It was pointed out before that ordinarily the five larger sizes, egg to buckwheat, only were completely cleaned in the sealed discharge plant. However, the quality of barley and No. 2 barley size washed coal is more than satisfactory and the loss of coal of this size in the refuse amounts to such a small tonnage of so little value that its recovery would not warrant the operation of the free discharge plant.

**TABLE I—SUMMARY OF TESTS RHEOLAVEUR SEALED DISCHARGE PLANT, LOOMIS BREAKER, GLEN ALDEN COAL CO., DECEMBER 22 AND 23, 1926**

| Sample | Main Feed | | | Washed Coal | | | Refuse | | |
|---|---|---|---|---|---|---|---|---|---|
| Distribution by weight | 100% | | | 91% | | | 9% | | |
| Sizes * | % Ash | % Float 1.95 | % Sink 1.95 | % Ash | % Float 1.95 | % Sink 1.95 | % Ash | % Float 1.95 | % Sink 1.95 |
| Egg | 18.81 | 89.0 | 11.0 | 6.5 | 100.00 | 0.00 | 75.5 | 1.21 | 98.79 |
| Stove | 17.70 | 88.0 | 12.0 | 6.5 | 99.75 | 0.25 | 84.2 | 1.42 | 98.58 |
| Nut | 15.65 | 90.0 | 10.0 | 7.6 | 99.31 | 0.69 | 80.2 | 0.52 | 99.48 |
| Pea | 14.40 | 91.0 | 9.0 | 7.2 | 98.69 | 1.31 | 80.6 | 3.09 | 96.91 |
| Buckwheat | 14.40 | 92.5 | 7.5 | 10.4 | 96.76 | 3.24 | 82.8 | 2.79 | 97.21 |
| Rice | 13.70 | 93.0 | 7.0 | 10.1 | 96.36 | 3.64 | 81.9 | 3.40 | 94.60 |
| Barley and Barley No. 2 | 15.90 | 90.0 | 10.0 | 12.9 | 93.64 | 6.36 | 61.4 | 21.50 | 78.50 |
| Composite | 16.12 | 90.0 | 10.0 | 7.68 | 98.78 | 1.22 | 80.2 | 1.76 | 98.24 |

* Size specifications (round hole screen).

**EFFICIENCIES BASED ON 1.95 SPECIFIC GRAVITY SEPARATION OF COMPOSITE, EGG TO NO. 2 BARLEY SIZES (According to Drakeley's Formula)**

Quantitative efficiency ..... 99.82%
Qualitative efficiency ..... 87.80%
General efficiency ..... 87.64%

| | | | |
|---|---|---|---|
| Egg | 3-7/16" by 2-½" | Pea | 11/16" by 9/16" |
| Stove | 2-½" by 1-9/16" | Buckwheat | 9/16" by 5/16" |
| Nut | 1-9/16" by 11/16" | Rice | 5/16" by 3/16" |
| Barley No. 1 and No. 2 | 3/16" by 3/64" | | |

In order that these results can be compared with other cleaning plants, we have shown the efficiencies based on a separation at 1.95 specific gravity as calculated by Drakeley's Formula, which shows a quantitative efficiency, i. e., the recovery of total float on 1.95 specific gravity in the feed, of 99.82 percent. The qualitative efficiency, or removal of the total sink in 1.95 specific gravity is 87.8 percent. These are unusually high efficiencies.

### Operating Economies

In addition to the very gratifying efficiency of the Loomis Rheo installation, the economies or savings in operating costs and increased recoveries have shown it a very profitable investment.

Due to the range in market prices of the various sizes of anthracite, so that the larger sizes egg, stove and nut bring about $8.75 per ton, while the smaller sizes bring progressively lower prices until barley sells for $1.00 to $1.50 per ton, the proportion of the larger sizes recovered has a very decided influence on the average price received for the entire output.

Since the Rheo went into operation at Loomis, the total tonnage recovered per mine car has increased slightly and the production of larger more valuable sizes, has increased markedly.

We feel these improvements can be credited entirely to the Rheo as no other changes were made in the breaker, or in mining conditions.

Loomis has also shown a decided reduction in labor for breaker operation with only slightly more than half the total output handled by the Rheolaveur. We are preparing to install additional Rheo units at Loomis to take the balance of the tonnage and careful estimates of the breaker labor force indicate a 50 percent reduction.

Maintenance costs have been extremely low. The Rheo has been in operation seven months and with the exception of the pump repair mentioned earlier no repair job of any magnitude has been required. Maintenance on the Rheolaveur system has consisted only of inspection of equipment, tightening of elevator bolts, etc., and a very small amount of chute steel replacement. We estimate that maintenance costs on the Rheo and pumps have amounted to about ½c per ton.

Tests made at Loomis showed a power consumption for the Rheo equipment, pumps and sizing of washed coal, of 0.75 KW Hr. per ton or approximately ½c per ton.

We do not find any increased demand for water to operate the breaker since the Rheo was installed and when the balance of the breaker is Rheo equipped, we plan to install clarification tanks on the return water which, we believe, will reduce the water requirements of the breaker and at the same time reduce the maintenance cost for the circulating pumps.

### Hazleton Shaft Rheolaveur Installation

This installation is at one of the properties of The Lehigh Valley Coal Co., near Hazleton, Pa. The information which I will present on this plant was furnished by Mr. Paul Sterling, mechanical engineer of The Lehigh Valley Coal Co., who supervised the design and erection of the installation.

A general view of the breaker is given by Figure 10 and the Rheolaveur is installed in the right hand section of the structure.

The installation is similar to that at Loomis in its general features, having two 32-in. washing launders with three boxes on each and one 20-in. rewash launder, also with three boxes making up the sealed discharge plant for washing egg to buckwheat sizes (3 7/16-in.

*Fig. 6—Loomis Breaker, Glen Alden Coal Co.*

In this connection, it might be explained that the practice in use with jigs cleaning this coal is to supplement the jigs cleaning the egg and stove sizes by hand-picking by boys on both coal end and refuse end so that market coal shall meet specifications and the coal loss in the refuse be reduced to a minimum. This practice, of course, involves a considerable labor charge and its efficiency is affected by the human factor so that results are not consistent.

A set of bone rolls was installed in connection with the Rheo to break down egg and stove bone, but have not yet been put into operation as it was desired to determine first what could be done without them. Operation to date indicates that egg bone only need be broken down.

The Rheo at Hazleton Shaft was placed in operation during February, 1927. Some difficulty was experienced

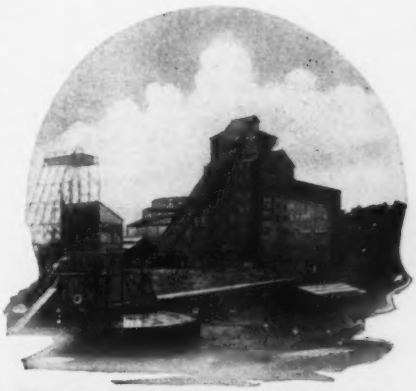


*Fig. 10—Hazleton Shaft Breaker, The Lehigh Valley Coal Co.*

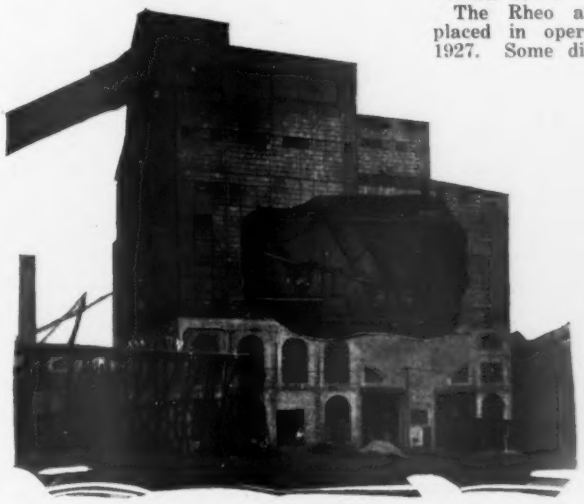


*Fig. 7—How the sealed discharge plant was installed in the Loomis Breaker*

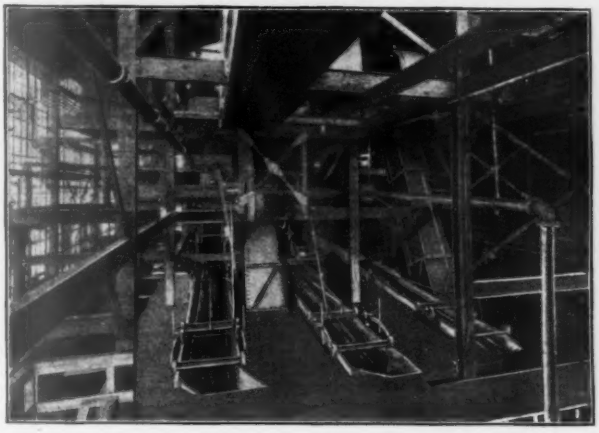


*Fig. 8—Complete Rheolaveur Plant, Loomis Breaker, Glen Alden Coal Co. Capacity, 350 tons per hour*

to 5/16-in.) and one free discharge unit for washing rice and barley (5/16-in. to 1/16-in.).

The coal treated in this breaker comes from five outlying mines as well as from the shaft adjacent to the breaker. This foreign coal is received in railroad cars and is dumped into a pit which receives the shaft coal and from there is hoisted to the top of the breaker by an inclined skip or gun-boat. The coal delivered to the breaker for cleaning shows quite a wide range in quality.

The feed to the Rheolaveur is egg and smaller, i. e., minus 3 7/16-in. from which no fines have been removed. This feed is a mixture of mud-screen coal and egg and smaller produced by breaking down larger coal after it has received a preliminary cleaning. The feed to the Rheolaveur averages 18 to 20 percent refuse, but at times contains as high as 35 percent refuse. In addition to the larger amount of refuse, this feed coal also contains a large proportion of bone, which makes its efficient cleaning difficult. Studies made on feed coal indicated that the bone averaged about 8 percent. As market specifications allow only 2 percent bone in egg, 4 percent in stove and 5 percent in nut, this preliminary study of the feed indicated that all the bone could not be put in the market coal and it would be necessary to separate an intermediate gravity bone product which should be crushed in order to free coal contained in this bone. As considerable of the bone is coarsely laminated such procedure was feasible. with water supply and mechanical matters, but these were soon eliminated. However, operation to date has been with only one washing launder of the sealed discharge plant so that only one-half the total capacity has been in operation. The complete installation was rated at 250 tons per hour of finished product or 2,000 tons output per 8-hour day. By the end of March, the Rheo was averaging 1,000 tons per day output or

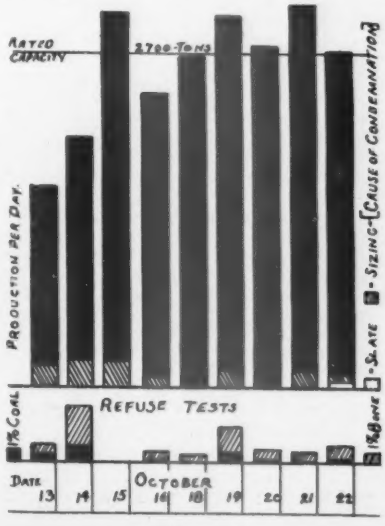



*Figure 9*

rated capacity for one-half the installation. The washed coal from the Rheolaveur has been of excellent quality with the exception of egg size. The high bone content of the egg has already been mentioned as the cause of difficulty in cleaning egg unless a bone product is crushed or hand-picking is resorted to. The Rheo coal produced in all other sizes invariably meets market specifications with a good margin of safety. The condemnation of Rheo stove and smaller sizes has been one-third of the condemnation from a like output of jig coal.

An average of Rheolaveur refuse tests from March 1 to May 1 shows almost identical quality with an average of the refuse from the balance of the breaker where refuse from the jigs treating the larger sizes is hand picked.

This installation has not been in operation long enough to give definite data as to all operating economies. However, it has shown a saving of at least 50 percent in operating labor.

The detailed information given on these two installations has shown that the Rheo has approached very closely the ideal requirements laid down for coal cleaning equipment. Our experience at Loomis has been so satisfactory that plans for completely equipping this breaker with Rheolaveur are now ready and the equipping of other of our properties is under consideration. Based on our own experience, we find the Rheo measures up to the ideal requirements as follows:

(a) The recovery of marketable coal is very high, indeed, being at Loomis

99.82 percent with a removal of from 85 to 90 percent of the refuse. The quality of washed coal is unusually high.

(b) Operation is very dependable and the product is of uniform quality. The condemnation at Loomis for refuse has been reduced to the vanishing point and the inspection tests on refuse are in close agreement from day to day.

(c) Market conditions have required coal of better quality during the past few months than ever before and at Loomis, this condition was met almost instantly by simply operating valves controlling the upward currents in the Rheo Boxes.

(d) Minimum breakage is an important requirement in anthracite preparation. Many anthracite operating men have felt that considerable breakage would be produced by the discharge from the Rheo inclined elevators such as are used at Loomis and we also were somewhat worried on that score. However, the overall results of Rheo operation showed that the breakage could not be serious and tests made of the elevator products showed that very little coarse coal is handled by the elevators but that their load is made up of refuse, bone and fine coal. These tests indicated that 80 percent of the coal larger than pea, i. e., the coal larger than 11/16-in. passed directly to washed coal pockets without entering an elevator. (See Table II for details.)

(e) The small space requirements of the Rheolaveur are illustrated by the Loomis installation, where the plans for equipment to clean the entire tonnage show it will occupy only slightly more than one-half the present breaker structure.

(f) *Low First Cost of Plant.* Anthracite breakers generally cost from $200.00 to $300.00 per ton of production per 8-hour day, depending upon capacity, the type of construction and the proportion of refuse which must be handled. Under like conditions, breakers using the Rheolaveur system of cleaning cost from $125.00 to $200.00 per ton of production per 8-hour day.

(g) *Low Operating Costs.* Labor costs at Loomis and Hazleton Shaft have been cut at least 50 percent. Seven months' operation at Loomis and four months' at Hazleton Shaft have shown practically no maintenance costs.

**TABLE II—LOOMIS RHEOLAVEUR SEALED DISCHARGE PLANT—COAL HANDLED BY ELEVATORS—TEST OF DECEMBER 22 AND 23, 1926**

| | Feed | | | No. 1 Elevator First Refuse Product | | | No. 2 Elevator Regulating Product | | |
|---|---|---|---|---|---|---|---|---|---|
| Total Tons Per Hr. | 313 | | | 93.5 | | | 117.5 | | |
| Sizes | % Size | % Float 1.65 | Tons/Hr. Float 1.65 | % Size | % Float 1.65 | Tons/Hr. Float 1.65 | % Size | % Float 1.65 | Tons/Hr. Float 1.65 |
| Egg | 10.77 | 81.0 | 27.3 | 6.75 | 31.7 | 2.00 | 0.0 | .... | .... |
| Stove | 23.36 | 81.5 | 59.5 | 17.52 | 30.2 | 4.95 | 0.0 | .... | .... |
| Nut | 33.08 | 84.5 | 87.5 | 35.30 | 38.6 | 12.75 | 22.7 | 58.4 | 15.6 |
| Pea | 5.47 | 85.5 | 14.6 | 8.30 | 42.2 | 3.38 | 8.7 | 63.3 | 6.5 |
| Buckwheat | 13.17 | 86.5 | 35.6 | 18.30 | 42.2 | 7.23 | 29.5 | 68.2 | 23.7 |
| | No. 3 Elevator Second Refuse Product | | | No. 4 Elevator Third Refuse Product | | | No. 5 Elevator Regulating Product | | |
| Total Tons Per Hr. | 56.7 | | | 32.3 | | | 29.5 | | |
| Sizes | % Size | % Float 1.65 | Tons/Hr. Float 1.65 | % Size | % Float 1.65 | Tons/Hr. Float 1.65 | % Size | % Float 1.65 | Tons/Hr. Float 1.65 |
| Egg | 11.86 | 4.1 | 0.28 | 13.91 | 5.2 | 0.23 | 5.3 | 51.1 | 0.80 |
| Stove | 32.60 | 14.2 | 2.62 | 28.04 | 2.7 | 0.24 | 19.0 | 29.7 | 1.66 |
| Nut | 37.72 | 19.5 | 4.17 | 37.60 | 7.1 | 0.86 | 38.9 | 30.4 | 3.50 |
| Pea | 3.77 | 22.4 | 0.48 | 5.06 | 4.9 | 0.08 | 8.2 | 23.2 | 0.56 |
| Buckwheat | 8.00 | 21.7 | 0.98 | 9.93 | 5.0 | 0.16 | 17.1 | 25.5 | 1.29 |

**PROPORTION OF FEED COAL (Float 1.65) IN VARIOUS SIZES CARRIED BY EACH ELEVATOR**

| Elevator | No. 1, First Refuse Product | No. 2, Regulating Product | No. 3, Second Refuse Product | No. 4, Third Refuse Product | No. 5, Regulating Product |
|---|---|---|---|---|---|
| | % | % | % | % | % |
| Egg | 7.3 | 0.0 | 1.0 | 0.9 | 2.9 |
| Stove | 8.3 | 0.0 | 4.4 | 0.4 | 2.8 |
| Nut | 14.6 | 17.8 | 4.8 | 1.0 | 4.0 |
| Pea | 23.1 | 44.5 | 3.3 | 0.5 | 3.8 |
| Buckwheat | 20.3 | 66.5 | 2.7 | 0.4 | 3.6 |
| Egg, Stove and Nut | 11.3 | 8.9 | 4.1 | 0.8 | 3.4 |

***MR. PAUL STERLING,*** *Lehigh Valley Coal Co.*, presented the paper prepared by Mr. Shelby Dimmick, due to Mr. Dimmick's unavoidable absence. In presenting this paper, Mr. Sterling said:

"Coal Cleaning by the Launder System as introduced by the American Rheolaveur Corporation takes advantage of the difference in specific gravity of coal, bone and refuse, and utilizes a flowing stream of water in a chute or laundry called the primary classification. The classification resulting from an upward current of water in some of the Rheo boxes and regulations resulting from returning a middling product high in bone or intermediate gravity material to the feed. Thus, the separation in refuse is between bone and refuse and on the coal end between bone and coal.

"This process does not require sizing before introduction to the launder. At present the maximum size fed passes through a 3½-in. ring, and is the size limitations of present equipment. If perfect washing is required through the entire range of sizes, the process is divided into two steps, 3½-in. to plus 5/16ths. The minus 5/16ths partially cleaned in the sealed discharge launder is retreated in a free discharge plant.

"In the anthracite field the Rheolaveur system has been in use only two years; to date, there are six plants in operation, to clean 300 tons per hour of minus 3½-in. coal to silt plant, to clean 20 to 25 tons per hour of minus 1/16th. The total annual tonnage in in excess of 2,000,000 tons.

"The Loomis plant of the Glen Alden Coal Co., was put in operation October, 1926, and has operated daily without any difficulty, and is handling approximately 3,900 tons of feed coal containing an average refuse of approximately 9 percent, and is recovering up to 1.95 gravity bone coal. Since the Rheo went into operation the total recovery per mine car has increased slightly, and the production of the valuable prepared or larger sizes increased perceptibly. They are now going ahead and installing Rheo equipment to handle the entire production.

"The experimental Rheo plant of the Hazelton Shaft Breaker of my company was started in February, this year, and as a whole has been very successful—so much so that we are arranging to install equipment to handle the entire feed, which will approximate 5,200 tons containing an average of 25 percent refuse. We have had a feed of 70 percent refuse for a short period, and I was amazed at the ease with which the operator handled that feed successfully.

"What we are trying to accomplish is a product on our cars without hand-picking which is necessary on our present jigged coal. We have had condemned coal in the egg size, but this condemned material was due to laminated pieces. This product which comes from the rewash is to be broken down and distributed in the smaller sizes. When the machinery for this is installed, we have every reason to believe that we will have a high recovery with a clean refuse, and will not, as a whole lower our prepared sizes but our figures show there will be a decided increase."

In the discussion following, ***MR. ANDREWS ALLEN,*** of *Allen & Garcia, Consulting Engineers, Chicago, Ill.*, said:

"It can be taken as an axiom in the washing of difficult coal that outside of a steady floating proposition, which can only be accomplished theoretically by high gravity, it is not possible to make a cut between clean coal and a clean refuse without a certain amount of recirculation. The air people recognize this. The developers of jigs and table washers have also recognized this.

"The Rheolaveur is specially notable in the fact that this recirculation idea is made a part of the process and is contained in every Rheolaveur system.

"The first trough gives you clean coal. The coal goes off the end of the trough without stopping. The bed saves the unclassified material and that is taken down and re-treated until it is crowded off one way or the other. To my mind there is no more reason why a coal that is wet-washed should stay wet, any more than that when you wash your fact with water you should leave it wet.

"Mr. Sterling only mentioned an anthracite plant. We built the first Rheolaveur plant for bituminous coal last year in Colo- (*Continued on page* 434)

# AIR CLEANING AT THE MONTOUR NO. 10 MINE, PITTSBURGH COAL COMPANY

*This Plant Erected To Mechanically Clean Smaller Sizes Of Coal—Air Cleaning Process Used, Which Is Proving Highly Satisfactory—Description Of Results Obtained Since Putting Plant In Operation In March, 1927*

By HOWARD W. MORGAN*

THE Montour No. 10 mine of the Pittsburgh Coal Company is located at Library, a small town about fourteen miles from Pittsburgh on the Montour Railroad.

Something over a year ago it was decided to proceed with a program of mechanically cleaning the smaller sizes of coal with a view to establishing choice commercial grades of coal from this mine. To this end a thorough examination of the coal was started, intended to demonstrate its behavior in a cleaning plant and its adaptability to mechanical cleaning. Both wet and dry cleaning processes were investigated. One of the features of this examination was the testing of a whole carload of coal on a commercial size air concentrator as a result of which it was decided to erect an air cleaning plant at Montour No. 10 for the treatment of the coal passing the 2½-in. diameter openings in the Marcus shaker screen. This plant was built and was put into operation shortly before the first of March, 1927.

The building is of completely fireproof construction, embodying a structural steel frame work with concrete floors, corrugated zinc roofing and spouting, steel sash windows, etc. The screening and cleaning equipment is in two parallel units exactly alike, and it is possible to run either side independently of the other. The following description is of a single unit, with the exception that the clean coal gathering conveyor serves both units. The coal to be treated is received in a raw coal conveyor running under the twin Marcus screens in the old tipple and is carried by means of a second similar raw coal conveyor to a raw coal bin of approximately 50 tons capacity. From the bin the coal is fed by means of a reciprocating pan feeder onto an inclined belt conveyor which carries the coal up a 20 degree angle to the cleaning plant. Here it is discharged to the first bank of Arms horizontal vibrating screens which prepare the coal for treatment on the tables. The screens are wire mesh with square openings and vibrate at 500 strokes per minute.

The screen sizes have been changed several times during the tuning up of the mill, and further changes may be made in the future. At the present time the sizes made are as follows:

| |
|---|
| 2½ inch round by 1½ inch square |
| 1½ inch round by 1 inch square |
| 1 inch round by ⅝ inch square |
| ⅝ inch round by 7/16 inch square |
| 7/16 inch round by 5/16 inch square |
| 5/16 inch round by 3/16 inch square |
| 3/16 inch round by 1/16 inch square |
| Minus 1/16 inch. |

The cleaning of the sized coal is done on Arm's Air concentrating tables, which, by a combination of an upward current of air with a jigging motion of the table surface, effect the separation or concentration of the highest specific gravity refuse from the light coal. There are eight of these tables in each unit on the floor below the screen. The air pressure varies somewhat on the different tables according to the size of the coal and the thickness of the bed, but the average used is close to three inches of water on the first table treating the coarsest coal and 1¼ in. of water on the table treating the 5/16 by 3/16 in. coal. Still lower pressure are used on the 3/16 by 1/16 in. coal.

There is a separate blower for each table. In addition to this there are three exhaust fans which collect the dust from above the tables and discharge it to Cyclone dust collectors. These fans maintain a negative pressure of approximately 3 in. of water over all of the tables.

From the concentrating tables the clean coal passes through to a gathering conveyor which collects the products of the various tables and conveys the mixture to a second similar conveyor at right angles to the first and running through the tipple across the railroad tracks with provisions for discharging its burden on any track. Each of these conveyors is built with two carrying compartments so that it is possible to keep the air cleaned slack separate from the air cleaned stove coal and load the two products on their respective track or to mix them both with the lump coal to make run-of-mine, or discharge the slack separately and mix the stove coal with the lump to form ¾ lump coal. An opening, provided with a gate in the bottom of one side of this conveyor, permits the taking of an intermediate size out of the building, by means of a cross conveyor without passing up to the tipple. This coal is loaded in cars on a siding parallel to the cleaning plant. The coal, now being loaded at this point, is known as stoker coal and consists of the combined sizes passing the 1-in. square opening screens and remaining on the 5/16 in. screens.

The refuse from all of the concentrators is discharged onto a common belt conveyor which delivers it to a refuse elevator. From the elevator the refuse discharges into a bin, set at a sufficient height so that the mine cars on the mine track level can be pulled therefrom and hauled away.

The middlings, taken off from the concentrators, go to a separate belt and are then discharged onto the raw coal belt conveyor for re-treatment through the system.

The preparation of the so-called stoker coal by removing the minus 5/16 in. material from the air-cleaned slack, leaves a resultant fine coal, all of which will pass a 5/16 in. square opening screen. This coal is known as air-cleaned powdered fuel. It is marketed for use in plants equipped for burning pulverized coal.

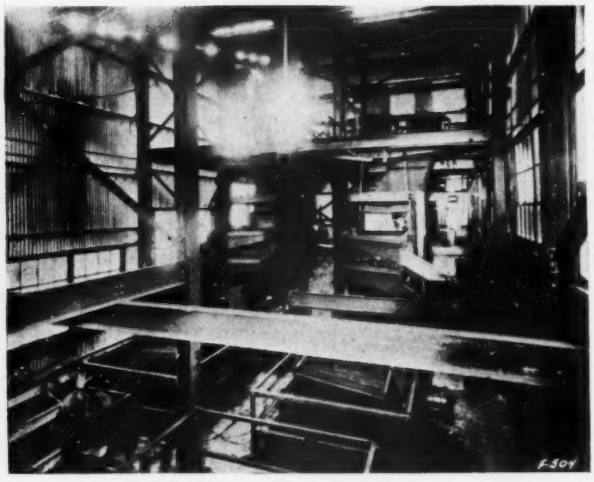
In addition to the mixtures of the air cleaned smaller sizes with the lump coal, the following sizes are now being made at this plant:

| |
|---|
| Air Cleaned Stove Coal—2½ in. by 1 in. |
| Air Cleaned Stoker Coal—1 in. by 5/16 in. |
| Air Cleaned Powdered Fuel—5/16 in. minus. |
| Air Cleaned Slack—Minus 1 in. |
| Air Cleaned Nut Slack—Minus 2½ in. round hole. |

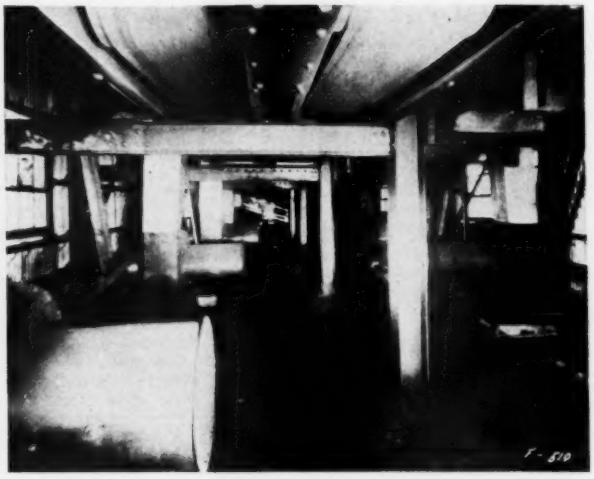
While it is expected that, as time goes on, the results will be still further improved, the coal produced during the past two months has been cleaned to a degree

*View of coal tipple and air cleaning plant, Montour No. 10 Mine*

* Director of Research, Pittsburgh Coal Co., Pittsburgh, Pa.




*Arms screens at Montour No. 10 plant of the Pittsburgh Coal Co.*




*View of fan floor, Montour No. 10 plant, Pittsburgh Coal Co.*

*Exhaust fan for dust collection system*

*Air concentrator table for separating impurities from clean coal*

closely approximating that shown by the preliminary test. The expectations of better results as time goes on is based on the improvement noticed in the quality of the coal for the month of April over that of March, and just now we are very hopeful of a still further improvement in the quality of the fine sizes brought about by the installation of the Bonson deck on the last three or four tables in the plant. One of these decks has been put into operation on the table treating the 3/16 by 5/16 in. material and a very marked improvement has been noticed both in the cleanliness of the coal and of the reject. That is to say, there is less slate and other impurities in the clean coal and there is considerably less coal in the reject. This deck consists of a woolen blanket placed over the wire mesh deck of the concentrator. On the feed side of the table this deck is elevated at both ends, forming a dish-shaped top at the rear sloping off to a plain surface at the front. In order to prevent the blinding of the cloth by dust, all of the air going to these tables is filtered through a canton flannel filter at the head of a duct from which all of the air for these tables is taken. Wool, rather than cotton is used on the deck due to the fact that cotton expands upon taking up moisture and the expansion would blind the opening.

The plant is under technical control. Every car of air cleaned coal shipped from the mine is sampled and analyzed at the mine. In addition to this, frequent samples are taken from the various tables and from the raw coal and refuse belts. Up to this time the sampling is being done by hand, but it is our intention to install a number of automatic samplers. The samples are pulverized by means of a Jeffrey swing hammer pulverizer, which permits the taking of large quantities without excessive labor in preparing them for the laboratory. The laboratory is equipped with fine pulverizers, a Delatester for making sink and float tests and two furnaces for ash analysis. The complete proximate analysis are run on composite samples or individual samples sent from the mine laboratory to our central laboratory in Pittsburgh, but it has been found that the various items entering into a coal analysis are so constant for a given percentage of ash, that the complete analysis and B. t. u. value can be calculated from the ash analysis made at the mine, and the central laboratory in the future, will be used only for check purposes.

The following are the average ash analyses for the various grades for the month of April:

| | |
|---|---|
| Nut-Slack | 6.63% |
| Slack | 7.90% |
| Stove | 6.68% |
| Stoker | 7.20% |
| Powdered Fuel | 8.19% |

These analyses represent the average of all cars shipped and the uniformity of the cleaning has been such that a variation from the average is strictly within the limits of laboratory error.

It has been found that at 7 percent ash, any of the above grades of coal will have a heat value of almost exactly 14,000 B. t. u.'s. The raw coal entering the cleaning plant analyzes between 9 and 9.5 percent ash.

The reject analyzes approximately 45 percent ash.

The amount of reject removed from the raw coal is approximately 3.9 percent.

The dry cleaning plant, as well as the original Marcus tipple, was designed and built by the Roberts & Schaefer Company, contracting engineers of Chicago, Illinois.

# DRY CLEANING OF COAL AT THE BERWIND WHITE OPERATIONS

*Method Used Has Obtained Gratifying Results And Has Proven The Wisdom Of Making Large Capital Expenditures—Progress Made Since Operation Of Plant Began In September, 1926, Outlined—Future Salient Requirements Of Mechanical Coal Preparation*

By CHARLES ENZIAN *

TO AVOID confusion in terms the reader is asked to bear in mind that this discussion of dry cleaning method of coal preparation is confined to the air or pneumatic system adopted by our company and now in practical operation near Windber, Pa., since September, 1926.

There probably is not a doubt in the minds of anyone engaged in the bituminous coal mining industry that one finds a relentless operation of the fundamental law of economics—supply and demand. There is no uncertainly as to the element "supply"; but everyone has many times, perhaps constantly, felt the severity of the uncertain demand for our product.

This discussion does not presume the discovery of any extremely original ideas, nor the final solution of all the problems of coal preparation, but it delineates the inception and application of mechanical appliances to solve the tremendously important problem of mechanization of mining as recognized by the management of our company several years ago; it also recounts the progress we have thus far made, and in a measure anticipates the future salient requirements of mechanical coal preparation. The results obtained by us have been very gratifying and have proven the wisdom of making the large capital expenditures.

*Dry cleaning plant at Eureka No. 37 Mine of Berwind White Coal Mining Co. "Courthouse" at right*

### DETERMINING THE NECESSITY FOR MECHANICAL COAL PREPARATION

The economic conditions of the bituminous coal industry which have existed in the past, and no doubt will exist in the future, require exceptional alertness on the part of the operator to create additional demand through the improvement of the product from his mines so that he may be insured of retaining the market already supplied and a reasonable hope of gaining new markets. This requires a somewhat comprehensive engineering and operating coal research program. It may therefore be interesting and perhaps helpful to here enumerate briefly the modus operandi of the principal elements of such a program:

1. Careful survey and analysis of the customer's requirements.

2. Thorough search and review of coal analyses available.

3. Provide a chemical laboratory, at central office, equipped to at least make ash and sulphur determinations.

4. Undertake a physical survey of coal deposits, product from the mines and facilities available for preparing the coal, and determine the necessity of undertaking a comprehensive program of face and tipple sampling. It will generally be noted that there is a wide difference between the analyses of face samples and tipple samples.

5. Make physical inspection and tests of the efficiency of hand preparation methods. This will generally be found to be considerably less than 5 percent of the efficiency of mechanical cleaning methods.

6. Determine by car-load samples tests in experimental plants the possible improvements of the hand picked mine product being shipped to market.

7. Make exhaustive study and analysis of the results of field, laboratory and test plant results.

### MARKET REQUIREMENTS

It must generally be presumed that the customer's requirements, whether real or imaginary, will be the producer's objective; this involves extensive field investigations and laboratory research work.

After obtaining all practicable information it is then possible to fix a nominal standard of quality of the product one desires to ship to market—keeping in mind that the primary object is to secure the best product it is practical to attain and the physical limitations one must always deal with in mechanical operations.

With these data established the next step is in the direction to adopt a cleaning method which will most practically ensure a realization of the fixed quality standard. This, of course, will entail some appreciable coal loss in preparation, but it must be borne in mind that we can not "eat the pie and still have the penny."

### PHYSICAL CONSIDERATIONS

The physical conditions under which a property is operated must receive careful consideration. One of the principal elements under this head are the mining conditions prevailing in the mine—the geologic formation of the coal deposits and the mining methods adopted; these must be carefully analyzed.

A close study must be made of the structure and relation of the various sizes of coal to the entire product and the impurities each contains, so that necessary facilities may be provided in the general program to handle the various products.

Another important element that requires serious thought and analysis is the climatic conditions prevailing in the mine locality. Extreme low temperature seasons involve considerable more difficulty in practical mine operation and marketing coal with a wet system of preparation than is experienced with a dry system.

In addition to these apparently serious obstacles one must decide whether it is more expedient to slightly contaminate the air than it is to invite criticism by polluting the drainage streams. These obviously are entirely local in their consequences and may or may not be of sufficient importance to determine the system to be adopted. The inherent objections of each system can be solved at a certain price; the operator must decide the relative importance of this cost.

### PLANT CAPACITY

After the daily shipping tonnage of the plant has been determined, careful consideration must be given to the relative sizes and quality of coal produced by the mine.

For Central Pennsylvania semi-bituminous, B or Lower Kittanning seam the screen tests indicate the following average sizes:

| SCREEN MESH | |
|---|---|
| Plus 3½" Rd. | 5 to 17 percent |
| 3½ Rd. by 2" Sq. | 6 to 8 percent |
| 2 by 1 Sq. | 5 to 6 percent |
| 1 by ½ Sq. | 6 to 31 percent |
| ½ by ¼ Sq. | 11 to 19 percent |
| ¼ by ⅛ Sq. | 8 to 17 percent |
| ⅛ by 1/16 | 10 to 14 percent |
| Minus 1/16 | 14 to 24 percent |

The commercial quality of this coal ranges approximately as follows: Ash, 5 to 10 percent; sulphur, 1 to 3 percent.

* Mining Engineer, The Berwind White Coal Mining Co., Windber, Pa.

It is practical to hand pick the sizes larger than 3½-in. round mesh, but the smaller sizes should be mechanically cleaned. The smallest size that can be efficiently cleaned in the latter group depends largely on the system adopted. It will be noted that that size represents a very large portion (83 to 95 percent) of the whole product and that the ash and sulphur content is such as to make it practically imperative that cleaning extend to the smallest practicable size. Our company's method involves the cleaning of plus 3½-in. by handpicking, and from 3½ to 0.11-in. is air cleaned; the major portion of the product smaller than 0.11-in. mesh is not cleaned at this time.

### Plant Layout

It is not practical to generalize on the layout of a cleaning plant. Therefore the physical and operating conditions at each mine, or group of mines tributary to a central cleaning plant, presents a separate and distinct problem. The physical or topographical condition of the mine location and the operating facilities to serve a cleaning plant must be carefully determined. Next one must take into consideration the serving equipment of the plant, and the practical limitations imposed by that equipment.

It is important that the rate of mine production and its variations be accurately determined. From the knowledge of just how intense the morning production of the mine is, and to what extent it shades off in the later periods of the day, the average hourly capacity of the plant will be determined. Ample mine car or bin storage facilities must be provided to allow for these fluctuations and the inevitable unforeseen delays due to railroad cars, power interruption, machinery failures, etc.

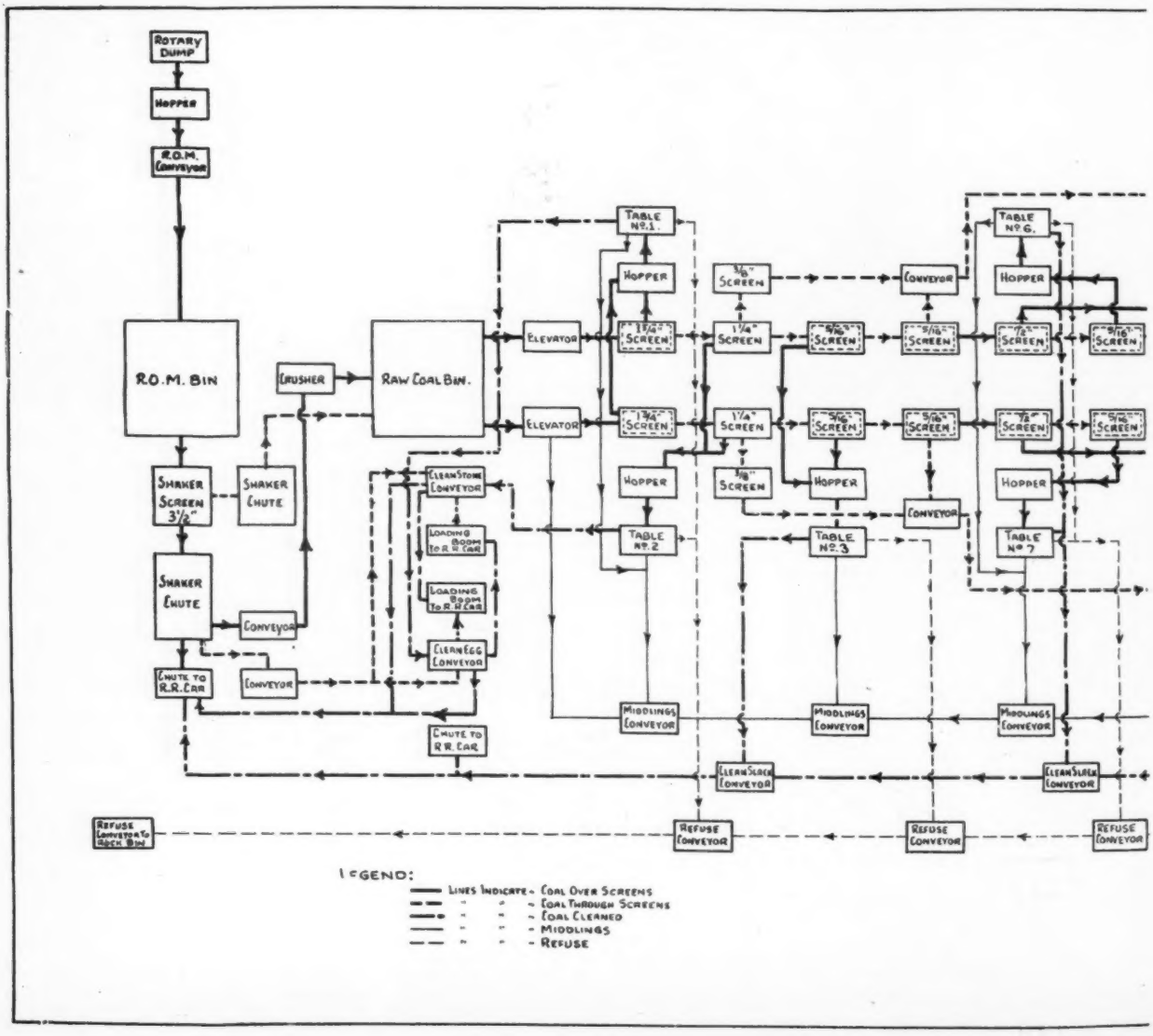
### Eureka No. 37 Operating Plant

The foregoing is a brief resume of the survey conducted by the operating and engineering officials of our company over a period of several years before the present cleaning plant was evolved, designed and constructed. This plant, designed and erected by the Roberts and Schaefer Co., was put on an actual operating basis during the latter part of September, 1926.

The loaded mine cars feed by gravity from the pit mouth to the rotary dump and from a "kick-back" run by gravity to the empty car yard on a lower than drift mouth elevation.

The coal and mine rock are dumped on a Car Dumper and Equipment Co. clear spillage rotary dump. The cars feed into the dump by gravity, and are controlled by a B-W. C. M. Co. retarder; the retarder and dump are operated by compressed air. Four men are engaged in the dumping of the mine cars—a weighmaster, a tripper, a checker and coupler, and the dump operator. These men attend to the oiling and cleaning of the machinery connected with this part of the plant and during waiting periods clean the tracks, dump, etc.

The dump hopper is provided with a mechanically operated flap-gate to by-pass the mine rock and the "court house" inspection coal to a 30-in. apron conveyor 100 ft. long between sprocket centers and operates on a grade of 30 degrees. It delivers the rock and also the "court house" coal to their respective chutes; the rock going to a reciprocating feeder and is delivered to the main refuse belt conveyor leading to the refuse bin south of the plant, and the court house coal is deflected by means of a chain rack-and-pinion operated flap-gate, to the inspection chute located directly over the main R. O. M. coal belt con-



veyor. The slack from the coal drops through a bar-screen onto the conveyor. After the court house coal is inspected it is scraped into a chute which also discharges onto the main R. O. M. conveyor.

From the dump hopper a 4½-ft. by 7-ft. reciprocating feeder feeds the coal onto the 42-in. 7-ply rubber belt main R. O. M. conveyor which operates on a 20° grade. This belt is 133 ft. long between centers of pullies and has a rated capacity of 540 tons per hour at a speed of 380 F. P. M. The belt is enclosed and is provided with 40 5-pulley troughing idlers and 12 tube return idlers, all equipped with Timken roller bearings. This belt discharges the run-of-mine coal into a 100-ton capacity storage bin from which a 5½-ft. by 8-ft. reciprocating feeder feeds it upon the 2-section balanced main inclined shaking screen 7½ ft. wide and 40 ft. long.

### New Tipple

As mentined before the tipple layout comprises the dump, run-of-mine conveyor, a 100-ton storage bin and the main shaking screen. The latter is divided into 2 sections, the upper section serving as a shaking screen and the lower section as a shaking chute. The upper section of the main shaking screen is provided with 14 ft. of 3½-in. diameter perforations to segregate the run-of-mine coal into the two desired groups, i. e. plus 3½ and minus 3½-in. The tonnage of these groups varies from 7 to 17 percent and 80 to 90 percent respectively. The plus 3½-in. sizes pass over the shaking chute section of the main shaking screen and are handpicked and discharged into the railroad car loading chute where it is mixed with the cleaned coal from the separator. The bony coal pickings go to a 12 by 24-in. flight cross-conveyor and are broken down to minus 3½-in. in a 30 by 30-in. single roll belt driven crusher located over the raw coal bin.

The handpicked refuse goes to a shaking trough mounted on top of the lower section of the shaking screen and are discharged directly into the main rock bin across the railroad tracks to the south of the plant.

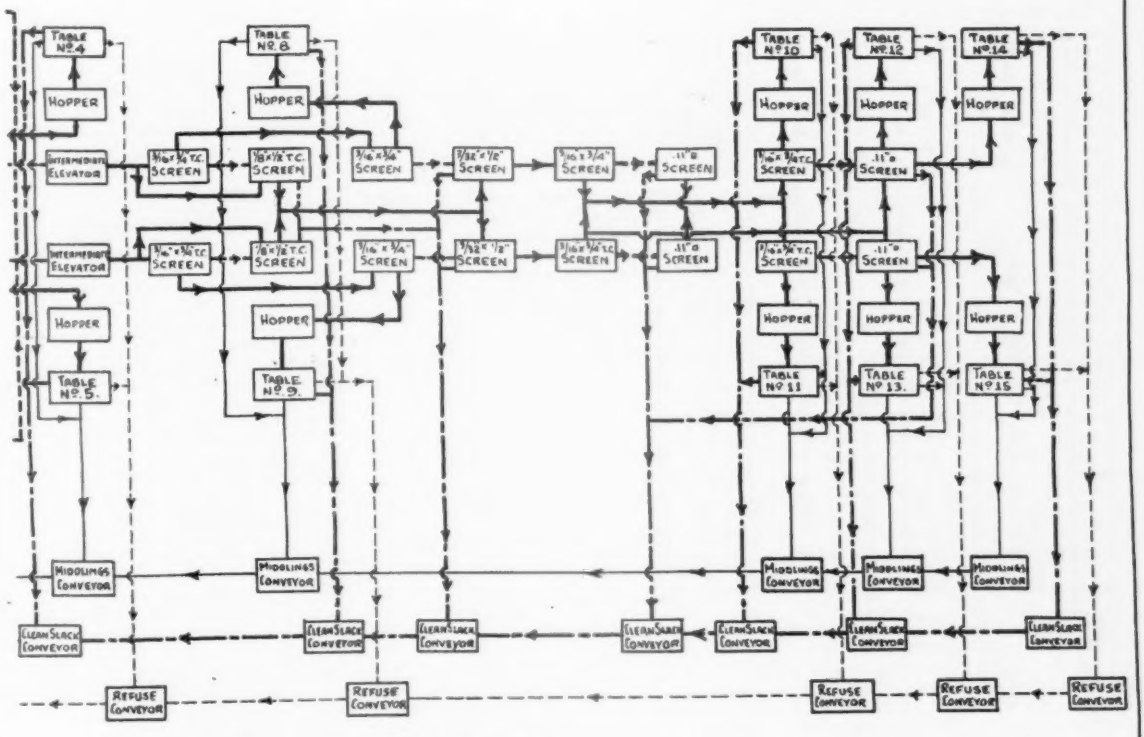
In the event of interruptions in the separator the output of the mine can be handled through the tipple as run-of-mine product. This insures against stopping delays of the mine due to failure of cleaning machinery.

The main shaking screen has a back-shaking receiving chute attached to its upper section which carries the minus 3½-in. coal to a 40-ton raw coal storage bin. From this bin the coal is fed by two 225-tons per hour capacity reciprocating feeders into the two 225-tons per hour raw coal elevators. These elevators are 50 ft. centers vertical and operating at a speed of 112 ft. per minute and deliver the coal to the main screens on the third floor of the separator building.

### Separator

The main separator building is 36 ft. wide and 110 ft. long and approximately 60 ft. high and comprises a fan floor, table floor and screen floor. The fans, tables and screens are arranged in two rows lengthwise along each side of the building.

Each of the two raw coal elevators mentioned above are of the continuous bucket type and are about 56 ft. sprocket centers vertical. The buckets are 42 by 12-in. and 18-in. pitch, equipped with 4-in. diameter rollers. The elevators




THE BERWIND-WHITE COAL MINING CO.
EUREKA No. 37, NEW TIPPLE.
FLOW SHEET
DRY PROCESS COAL CLEANING PLANT -
1926.

have a capacity of 225 tons per hour at a speed of 112 F. P. M.

These elevators discharge upon two trains of course screens dressed with 1¾ to ⅜-in. square mesh cloth. The sizes larger than ⅜-in. flow directly to the first seven Arms air concentrator tables.

The sizes smaller than ⅜-in. are re-elevated by two intermediate continuous bucket elevators 30 by 9 by 12-in. pitch, about 20 ft. sprocket centers on an inclination of about 83 degrees. Each elevator has a capacity of 125 tons per hour at 100 ft. per minute speed. These elevators also discharge upon two trains of fine screens dressed with 5/16 by ¾-in. T. C. to 0.11 square mesh screen cloth and the coal passing these screens go directly to the eight Arms air concentrator tables. The coal smaller than 0.11 is by-passed to the clean coal belt conveyor.

In appearance the Arms air tables very much resemble the Wilfley ore concentrating tables. The deck of the Arms table, however, consists of punched plates and screen cloth dressings through which air, as the separator medium, is applied to the coal. Riffles are mounted on the screen cloths to guage the height of air flotation necessary to secure the proper separation. These also serve to convey the refuse along the table to the high end where it is discharged into the refuse chute. The cleaned coal is taken off the side of the table near the front end and the middlings are taken off at the side near the rear end.

Each table has a separate fan. The motor driving the fan also supplies the head-motion to the tables. The cleaned coal flows to the clean coal gathering conveyor which has a 30-in. belt, 92-ft. pulley centers and a capacity of 325 tons per hour at 435 F. P. M. It discharges into a flight cross-conveyor. The middlings conveyor is a 14-in. belt conveyor, 106-ft. pulley centers with a capacity of 40 tons per hour at a speed of 300-ft. per minute. This conveyor discharges into the 2 raw coal elevators and the product is recirculated through the plant. The refuse conveyor is a 14-in. belt 124-ft. pulley centers with a capacity of 50 tons per hour at 300-ft. per minute speed. The clean coal flight cross-conveyor is 12 by 36-in. and about 52-ft. pulley centers. It has a capacity of 325 tons per hour. The egg and stove size coal, or coal from tables 1 and 2, flows directly to a two-compartment flight cross-conveyor, which has a capacity of 65 tons per hour at a speed of 100 ft. per minute. The flights are 8 by 30 in. The 2 flight cross-conveyors discharge into the loading chute and the coal is mixed with the hand-picked coal off the shaking chute. If desired, the egg and stove size can be loaded separately off the loading booms or combined in any desired proportion.

The gathering refuse conveyor discharges upon the main belt rock conveyor, which is a 30-in. belt, 100-ft. center to center of pullies, and runs at a speed of 200 F. P. M. The belt is supported by 29 5-pulley troughing idlers, 11 tube return idlers, and 2 sets of guide idlers—all equipped with roller bearings.

The table fans are of various sizes and operate at pressures ranging from 1½ to 6-in. water gauge. Three Sturtevant No. 90 exhausters circulate 180,000 cu. ft. of dust laden air per minute to the 3 Sturtevant No. 60 cyclone dust collectors. Considerable difficulty has been experienced with the dust collecting appliances due to the large quantity of air circulated and the comparatively low efficiency (75 to 85 percent) of the cyclone collectors. Experience has disclosed the imperative necessity of providing air purifiers in conjunction with the cyclones, or installing a dust collecting system that will ensure approximately 98 percent dust precipitation. Extensive experiments have been made with several commercial types of dust purifying systems, and to control the table and dust collecting air. The results indicate that these difficulties will be satisfactorily solved very shortly.

The total connected motor-horsepower required to operate the separator is 820—which represents 83½ percent of the entire motor-horsepower required to operate the new plant.

To keep the plant clean and tidy it was found advisable to install a vacuum cleaning system. A Tabco vacuum producer, manufactured by the Allen and Billmeyer Co., was installed, and has been found very satisfactory. The air exhausting from the multiple-bag dust collector and separator of the system is estimated to contain less than 2 percent of impalpable dust.

The tipple and separator buildings are heated with two A-303 Buffalo Forge Aerofin system heaters.

The plant has ample fire protection. Water is supplied in a 6-in. main connection to the main water supply. This is augmented by limestone dust filled fire pails and chemical fire extinguishers.

To insure against possible incipient fires from electrical installations or negligence of workmen and for general property protection, the plant is patrolled by a watchman during the idle hours of the day.

The separator has a complete sampling, and float and sink test equipment, and on the ground floor, immediately under the dust collecting fan space of the upper floor, a store-room for equipment supplies and repair parts will be provided later.

### Refuse Disposal

The mine rock and separator refuse, and the pickings from the picking chute are collected in the main refuse bin on the south side of the main building across the railroad tracks. From the bin the refuse is transported to the rock dump in a six-ton larry running out by gravity but is returned to the bin by a small electric hoist.

The mine rock consists of the rock and bone coal loadings of miners at the working face and road-cleanings.

The hand-picked picking chute refuse consists of sulphur, bone and slate, and the refuse from the separator consists of sulphur, slate, bony coal and preparation-loss coal.

In a recent test the various kinds of hand-picked refuse represented 2.34 percent, 1.64 percent and 0.68 percent, respectively, or 4.66 percent of the total plant cleanings. The separator refuse amounted to 95.34 percent—or approximately 20 times the amount of hand-picked refuse. The total refuse, or rejects from the cleaning plant, represented 3.2 percent of the total mine product handled in the plant. The hand-picked refuse analyzed 44.55 ash and 10.71 sulphur, and the separator refuse analyzed 42.59 ash and 18.56 sulphur. These results compare very favorably with the results obtained in the experimental plant tests. The clean coal tests indicate a range in ash and sulphur reduction from 12.34 to 14.7 percent, and 18.75 to 28.4 percent respectively.

As may be expected, in a pioneer installation of this kind, numerous physical and mechanical difficulties were encountered in the design, construction and early operation of this plant. Many perplexing problems developed as we progressed. The important necessities were recognized by the builders and the company, and through combined determination and effort most of them have been solved satisfactorily. Much, however, is still to be learned in this phase of efficient modern mining operation, and no doubt future installations will entail considerable less trouble than we experienced in getting the operation of this first plant coordinated to its present state of efficiency.

The total cost of the plant is approximately 7 percent of this amount, representing grading of plant site and relocation of tracks; $940 per hour-ton capacity. However, we expect that this unit cost will be appreciably less in future installations.

The total cost of air cleaning our product at this plant adds approximately 6.4 percent to the previous mine costs—equally divided between operating costs and capital charges.

This additional operating expense seems entirely justified by the improvement that can be realized in the shipped product from a mine that produces coal of variable quality. The quality of the cleaned coal is practically uniform. This will avoid many unpleasant trade situations, and will insure a more continuous operation of the mine, and will make it possible to supply a market otherwise impossible to approach.

Mechanical coal preparation appears to hold out the one real hope for practicalizing the general application of the most efficient mechanical mining methods.

It must not be inferred that the author, in any manner, desires to convey the impression that mechanical coal cleaning will provide a panacea for all the ills that beset the bituminous operator not now equipped with such facilities, but the results we have thus far attained with the air-cleaning process give great promise of successfully meeting the more exacting demands of the consumer. The savings that can be effected in mining cost, by the more general adoption of mechanical mining methods, more than offset the cost of air cleaning the output of a mine. It is desired to emphasize the important relationship that exists between *mechanical coal mining* and *mechanical coal preparation.*

Another point that is desired to be emphasized is the fallacy of the generally mistaken attitude of the mine official that he can load out any kind of a product if he has a cleaning plant. It is true he can, to a reasonable extent, capitalize this feature and load coal less painstakingly, but he must keep in mind that a cleaning plant can not recover the loss that is sustained in paying the mining rate for the unmarketable material he permits the miner to load out. Such factors, taken in conjunction with the unavoidable preparation and market losses, may spell the difference between profit or loss in operation.

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***MR. FRANK E. MUELLER,*** *Vice President, Roberts and Schaefer Co., Chicago, Ill.,* led the discussion following the presentation of Mr. Enzian's remarks, saying:

"When you listen to papers like those presented here (*Continued on page* 461)

# CLEANING WEST VIRGINIA COAL

*Description Modoc Dry Cleaning Plant—Seam Contains Four Impurities, Draw Slate, Sulphur, Band, Heavy Slate and High Ash Coal—Plant Has Been In Operation Three Months And Results Obtained Closely Approximate What Was Expected From Preliminary Tests*

By MILO W. SUMMERS*

THE subject, cleaning West Virginia Coal, would take considerably more than the ten minutes allotted to me, so my remarks will be confined to some of the details of construction and operation of the Modoc dry cleaning plant of the Turkey Gap Coal and Coke Co.

This plant was put in operation on March 19, 1927, and has operated continuously since that time without as much as one minute's delay.

The mine is located on Bluestone Branch of the N. & W. Railroad, operating the Pocahontas No. 3 seam which is some 60 ft. above the tipple.

There are four impurities in the seam to be considered. First of all, the draw slate. This is the usual slaty formation found directly above the coal and is high enough in specific gravity to insure separation on the tables without difficulty.

Secondly, the sulphur band. This is a thin heavy band, located about 2 ft. above the bottom of the coal.

Thirdly, the heavy band. This occurs in the middle parting. It has an ash content of 50-55 percent and a specific gravity of 1.6.

Fourthly, the high ash coal, also occuring in the middle parting, distinguished by its greenish caste on exposure to the air. It has an ash content of 20 percent and specific gravity of 1.4.

These impurities become mixed with the coal to some extent in the mining operation, although, as will be seen, they do not affect the coal below ⅜ or ¼ in. in size. This size, by the way, constitutes two-thirds of the total slack and analyzes about 6 percent in ash. Hence ⅜-in. was decided upon as the lowest limit of cleaning.

The American Coal Cleaning Corporation of Welch, W. Va., conducted tests on a shipment of 25 tons of this coal. These tests served to determine what sizes decided cleaning and the extent of the impurities. The tests were conducted on the S. T. and W. Y. C. type tables.

Accordingly a 3-table dry cleaning plant was designed treating ⅜ to ¾ on No. 1 table, ¾ to 1½ on No. 2, and 1½ to 2½ on No. 3.

The impurities break up into egg and nut sizes in the mining operation, and it was in order to improve the preparation given these grades that the dry cleaning plant was built. Little difficulty is experienced with the impurities getting into the slack. The American Coal Cleaning Corporation conducted tests on this coal to determine what results might be expected in a plant using their SJ type separators. Previously, screen tests and ash analyses had been made to ascertain the sizes which contained the foreign matter. The following table summarizes the findings of this study.

* Engineer, Turkey Gap Coal & Coke Co., Dott, W. Va.

TABLE I—WITH +4-INCH SCREENED OUT

| Size (Inches) | Percent of Size | Crude coal Ash Pct. | Clean Coal Ash Pct. |
|---|---|---|---|
| 4 on 1 1/2 | 8.7 | Hand Picked | |
| 1 1/2 on 1 | 7.6 | 19.84 | .... |
| 1 on 3/4 | 5.1 | 23.68 | 5.18 |
| 3/4 on 1/2 | 6.7 | 13.88 | 5.01 |
| 1/2 on 1/4 | 7.8 | 7.01 | 4.92 |
| 1/4 on 1/8 | 15.3 | 7.73 | 4.85 |
| 1/8 on 1/64 | 42.8 | 8.67 | 5.21 |
| Through 1/64 | 6 | 9.88 | 5.13 |

Accordingly a three-separator dry cleaning plant was designed ⅜ to ¾ in. on No. 1 table, ¾ to 1½ in. on No. 2 table, and 1½ to 2½ in. on No. 3 table. The coal is conveyed to the dry cleaning plant by combined scraper conveyor and bucket elevator of 150-ton per hour capacity, after having been separated from the mine run on a horizontal shaking screen having 1¾ by 2 by 10-in. slotted openings. The sizing for treatment on the air tables is accomplished by HUMMER electric vibrative screens. These screens are equipped with ⅜, ¾ and 1½-in. screen cloth and the coal as discharged from the elevator is screened in that order. The minus ⅜-in. coal is bypassed and discharged directly into the rope and button conveyor which also carries the plus 2½-in. coal to the bottom to be screened for shipment. Under each screen a bin of 7 tons capacity is located which served to take care of the surges and for storage capacity in the event that it is necessary to stop the air table. A rotating disc feeder is located at the bottom of each storage bin, discharging into the feed hopper on the pneumatic table. This feeder was designed for the plant by the Jeffrey Manufacturing Company. This company also furnished all conveying machinery in the dry cleaning plant. The pneumatic tables are of the SJ type, furnished by the American Coal Cleaning Corporation. Three products are made on these tables—clean coal, middlings and refuse. The clean coal from each table is discharged into a chute which leads to the rope and button line. The middlings from all tables are gathered on an 18-in. belt conveyor and discharged into the main raw coal conveyor being in closed circuit and thus retreated on the tables. The refuse is gathered by belt and scraper conveyors to a 20-ton bin from which it is trucked.

The dust collecting equipment consists of one 15-ft. centrifugal collector, one 80-in. exhausting fan, hoods over each table and taps to the storage bins above the tables. This equipment was furnished by the B. F. Sturtevant Company. The centrifugal collector discharges by gravity into the rope and button conveyor.

Although this plant has been in operation less than two months the results obtained have closely approximated what was expected from the preliminary tests. These tests showed as follows:

| | Percent Size to Whole | Crude, and Middlings (Percent) | Clean Coal | Rejection (Percent) |
|---|---|---|---|---|
| ⅜ to ¾ | 10.6 to 9.3 | 7.37 | 4.88 | 18 |
| ¾ to 1½ | 12.7 to 11.2 | 21.76 | 5.18 | 24 |
| 1½ to 2½ | 5.7 to 5.0 | 19.84 | 6.00* | 15 |
| Average | | 17 | 5.13 | 20.1 |

* No analysis.

Discussion following Mr. Summers' paper was led by ***Mr. WILLIAM J. O TOOLE.*** *American Coal Cleaning Corporation,* during which he stated that:

"If coal is cleaned by water you first have to provide the water, then, of course, you have to wet the coal. Then the coal has to be dried to get the moisture out of it. Then you have the fine coal in the water. You have to get the coal out of the water before it can be turned into the streams.

"When the coal is cleaned by air, the air is plentiful, and the coal is dry after cleaning, but there is some fine coal dust in the air used to clean the coal. The air can be turned into the atmosphere if you want to pollute the atmosphere like uncleaned water pollutes the streams; but if it is desired to take the coal dust out of the air, which I think it is, is can and is being done.

"At this time when everyone is trying to reduce the cost of mining and preparing coal—and there is a considerable movement on for the conservation of waste in industry—it might be well to look a little closer home and see what might be accomplished. Practically every coal operator is throwing away over his refuse dump a low ash impurity and shipping a high ash impurity in his coal. The reason for this is that the low ash impurity occurs in the larger sizes of lump coal and is easily detected by the consumer while the high ash impurity occurs in the fines, and can not be picked and is not so readily detected by the customer except on analysis or after burning. At the same time practically everyone admits that there is excessive impurities in the fines as shipped and it would be desirable to eliminate all or at least a portion of it. Why not, therefore, substitute the low ash impurity for the high, obtain a reduction in the ash content of the coal and at the same time cut down the loss of product due to cleaning, perhaps eliminate this loss entirely, or under favorable conditions have an increased quantity for shipment. Some coals are sold on an analysis basis and it seems certain that more will be so sold in the future. It should not concern a consumer as to how his specifications are met as long as they are met; it is simply a coal preparation problem for the coal operator.

"One mine that I know of is doing this. The fine crude product contains approximately 10 percent ash and consists of about 90 percent coal at 4.5 ash, 8 percent heavy impurity at 70 percent ash, 2 percent light impurity at 20 percent ash. (*Continued on page* 454)

# RESULTS OBTAINED IN CLEANING COAL AT ALGOMA COAL & COKE COMPANY

*Dust Collectors Remove Tipple Dust—Remote Motor Control Throughout—Significant Lowering Of Ash Content In Fines—Wide Flexibility Of Adjustment To Meet Varying Conditions And Sizing*

*By* WILLIAM BEURY *

THE fall of 1926 saw the starting up of the new plant of the Algoma Coal and Coke Co., located on a branch of the N. & W. Railroad, near Northfork, W. Va. This company is engaged in mining the famous No. 3 Pocahontas Seam, and is one of the pioneers in this field. Recognizing the necessity of meeting the growing demand for cleaner coal—the officers of the company long ago started investigating the available methods of coal preparation with particular reference to their own problem. Included in this investigation was what might be termed a "cleanability" test of a carload sample, intended to demonstrate the probable behavior of their coal in a plant under operating conditions. This program of investigation has been of tremendous value, as it has made possible the building and starting up of a large and well equipped preparation plant with a minimum of lost motion and delay in swinging into actual productive operation.

The plant itself is of steel construction with wood floors; ample lighting and ventilation are provided by means of skylights and pivoted sash windows and special emphasis was placed on the lighting of the picking tables. Coal is brought to the tipple over a tram-road along the hills, and dumped over a cross-over dump into a large receiving hopper. From here it is fed into a Marcus horizontal combination shaker screen and picking table, where the lump and egg sizes are separated and the impurities picked out by hand. Space is provided for 14 pickers, who are able to remove all the visible impurities from these two sizes. All the coal which passes the 2½-in. diameter openings in a flat screen plate is collected in a bin and then elevated to the top of the cleaning plant. The cleaning plant is what is known as a "dry process" installation, and is equipped with "Arms" air concentrators for removing the impurities from the coal. The discharge from the elevator is divided into two streams, each going to a separate bank of "Arms" horizontal vibrating screens which separate the coal into the proper sizes for treatment on the concentrating tables. From the screens each size passes to its respective table, a small bin being placed at each concentrator to provide storage against fluctuations in the screen analysis which would vary the feed to the table. After treatment on the tables the clean coal is chuted into the clean coal gathering conveyor and conveyed back to the loading point at the tipple, where it can be loaded in various combinations with the picked lump and egg. Refuse from the tables is handled in one side of a two-compartment conveyor and delivered, by means of the main gathering conveyor, to the same bin which receives the refuse picked off the Marcus. The second compartment of this conveyor handles a "middlings" product from the concentrating tables—delivering it to the boot of the raw-coal elevator for retreatment with the rest of the coal. The main gathering conveyor is built with three carrying compartments, in order to make it possible to deliver air-cleaned nut coal to the loading point coincident with the loading of cleaned slack. The third compartment of this conveyor takes table refuse to the bin, as mentioned above. A bin is provided for the collecting of a carload of nut coal when this is desired.

Eight air concentrating tables are used in the cleaning plant for cleaning the coal between 2½-in. and 1/16-in. in size, it having been decided that the desired results could be obtained without treating the coal below 1/16 in.

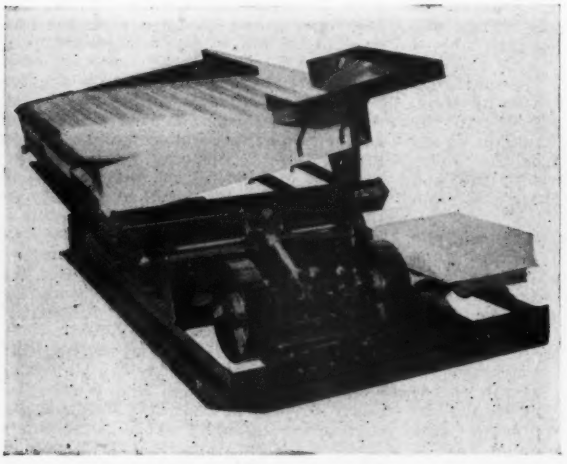
Each table is equipped with a dust hood, these hoods being connected up with two "Cyclone" dust collectors. The dust so collected is returned, continuously, to the cleaned slack. It is worthy of note that dust conditions in this plant have been, at no time, abnormal, the cleaner being fully as habitable as any ordinary tipple.

All motors are equipped with remote control and the controls centralized in two groups—one for the tipple, and one for the cleaning plant. Each control station is equipped with an emergency stop switch, by means of which the entire plant can be stopped, if necessary.

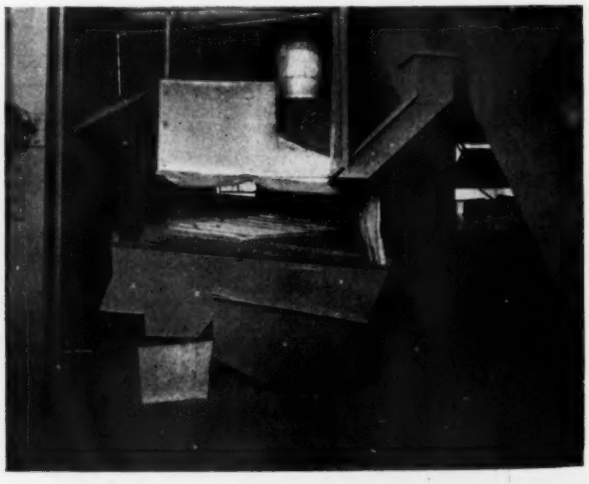
With the equipment installed here it is possible to load hand-picked lump, hand-picked egg, air-cleaned nut, air-cleaned slack, as well as various combinations of the above sizes, in addition to cleaned run-of-mine coal. The lump and egg sizes, being rescreened and loaded over shaker loading booms, go into the car with no breakage and without any unscreened fines, resulting in a very fine grade of Pocahontas lump and egg. Of still greater interest are the results being obtained in the elimination of the ash content in the smaller sizes, particularly in the range where picking is out of the question and where the results from mechanical cleaning have been, hitherto, open to considerable speculation.

On the ⅛-in by 1/16-in. size an analysis showed the ash in the raw feed to the two tables to be 10.70 percent and 7.16 percent, respectively. The ash in the clean coal, determined from samples taken at the same time as the raw samples, was for the same two tables 4.32 percent and 6.03 percent. The average ash reduction for this size, then, is from 8.93 to 5.17 percent. On the ¼-in. by ⅛-in. size the average reduction, figured on the same basis as above, is from 10.40 percent ash in the raw feed to 7.3

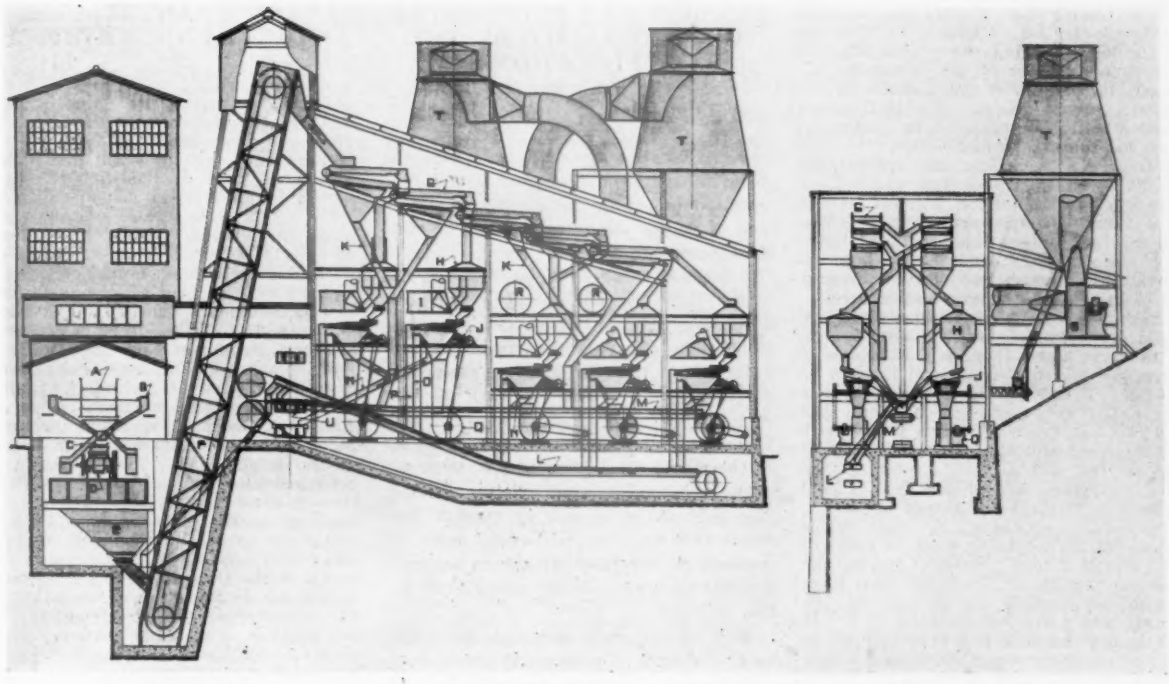
* General Superintendent, Algoma Coal and Coke Co., Algoma, W. Va.



*Arms Air Concentrator*



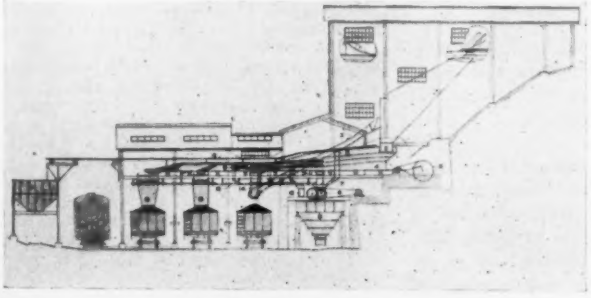
*Nut table in dry cleaning plant of Algoma Coal & Coke Co.*



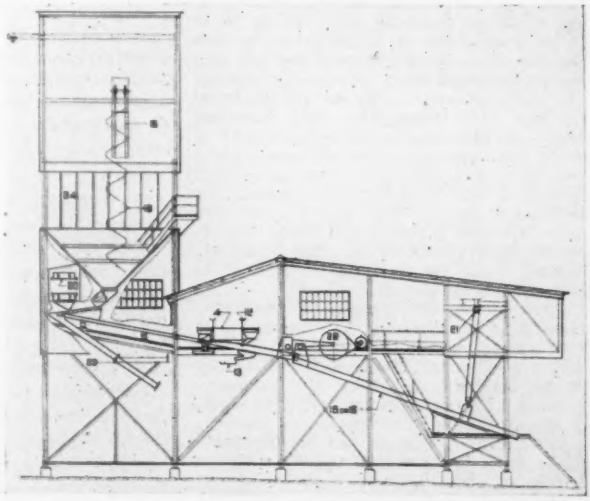
*Longitudinal and Cross-Sections Through Dry Cleaning Plant of the Algoma Coal & Coke Co.*

A. Marcus Screen
B. Pickers Chute
C. Raw Coal Chute
D. Crusher
E. Raw Coal Bin
F. Raw Coal Elevator
G. Arms Screen
H. Table Storage Hopper
I. Dust Collecting Hood
J. Arms Concentrator
K. Undersize Chute
L. Middlings and Refuse Conveyor
M. Cleaned Coal Conveyor
N. Cleaned Coal Chute
O. Middlings Chute
P. Refuse Chute
Q. Concentrator Fan
R. Dust Collecting Pipe
S. Dust Collecting Fan
T. Dust Collector
U. Cross Conveyor

1, dump hopper; 2, feeder; 3, run-of-mine chute; 4, Marcus screen; 5, Marcus screen drive; 6, pickers chute; 7, slack chute; 8, crusher; 9, raw coal hopper; 10, rescreen chute; 11, screen roller; 12, refuse trough; 13, rescreen and bone coal trough; 14, slack chute; 15, egg loading boom; 16, lump loading boom; 17, refuse bin; 18, nut elevator; 19, spiral chute for nut coal; 20, refuse and cleaned slack and nut conveyor; 21, boom hoist; 22, boom drive; 23, nut loading chute; 24, nut bin.



*Section through tipple and boom house, Algoma Coal & Coke Co.*



*Section along nut loading boom, Algoma Coal & Coke Co.*

percent in the clean coal. These results are being obtained with about a 5 percent rejection for the entire cleaner, based on the coal actually fed to the cleaning plant. A survey of the overall results from the cleaning plant shows that, when loading run-of-mine coal the cleaner is delivering to this mixture a 2½-in. slack, constituting about 70 percent of the whole, and having an average ash content of 6.7 percent, this having been reduced from 9.47 percent in the raw feed to the cleaner.

Of perhaps equal value with the actual reduction in the amount of ash present in the cleaned coal, is the feature of ash control. It is a known fact that a great many consumers of coal are not only interested in the actual ash analysis, but in its uniformity and experience has already demonstrated that it is possible, at the Algoma plant, to control the ash in the product so as to realize a benefit from this circumstance and prevent the operators from being at the mercy of the way coal is loaded in the mine.

An interesting feature in connection with the operation of the Arms Air Concentrator, is the complete visibility of the separation process, as well as the possibility of adjusting, to meet varying conditions. The entire table bed can be observed, and it is possible to make adjustment, while running, to vary the amount and quality of the refuse, the middlings, or the clean coal.

The plant was designed and built by Roberts & Schaefer Co., of Chicago.

***MR. JERRY MACHAMMER,*** *Roberts and Schaefer Co., Chicago, Ill.,* led the discussion following the presentation of Mr. Beury's paper by Mr. Humphrey D. Smith, on account of the absence of the author, due to illness. Mr. McHammer showed a number of slides in connection with his remarks, which follow:

"Generally speaking, the advantages of air cleaning are as follows: Higher recovery is possible on account of the fact that the fines are recovered and not lost as sludge; the production of a dry, clean product, and the no less important advantage of clean streams, which in some districts are quite rare.

"The disadvantages, unfortunately, are about as numerous as the advantages. In the first place, there is a difficulty of screening the fine coal, which may be twofold. It may be due to the fact that the coal is wet, containing not only the fine coal but fire clay, which will adhere to the screen and blind it, and it may be due to the difficulty of screening the finer materials through the bed of coal as well as through the screen mesh.

"Generally speaking, the coal to be cleaned on an air table must be sized in the ratio of 2 to 1. In other words, the smallest particle on the table must have a size represented by a unit in the largest and a size represented by 2. If this is not the case and sufficient air is used on the table to get the largest pieces of coal in the clean coal where it belongs, you will find that the smallest pieces of refuse will also be with the clean coal, which, of course, is not what you are looking for.

"On the other hand, if the reverse is tried, we find that the large pieces of coal are in with the refuse.

"If we adhere to the ration of 2 to 1, and we are treating the product from ¼-in. to 0, of course, the logical thing to do would be to screen from ¼ to ⅛ to 1/16, and there we would have to stop because we couldn't screen further and screen economically. Certainly not if the coal was wet. We have considered ⅛ and 1/16 impossible. We have not had insurmountable difficulties at ¼ from the type of screen we use, and if we stopped at ⅛, where we have been able to a certain extent to overcome the difficulties which are present, we are then left with a product of from ⅛ to 0, which must be handled. We have deviated from the original course of a 2 to 1 ratio on the table.

"The latest development of fine coal cleaning will be along the treatment of this unsized material from ⅛ to 0. The result will be accomplished, I believe, by using smaller quantities of air, maintaining a higher pressure below the deck, a more uniform distribution of the air, maintaining a heavier bed on the table and a more uniform and regular reciprocation of that deck in order that the statification which you have obtained within the feed box, or anywhere along the deck, before a discharge has taken place, will not be destroyed.

"Our latest developments in the cleaning of fine coal have been along the line of substituting other materials than the wire screen for this perforated surface. We have had the greatest success with a heavy wool cloth. Almost the same result can be obtained with a cotton cloth, except that the disadvantages are that the cotton cloth, by the absorption of moisture, will stop the flow of air, and if there is any fire clay in the fine coal you find that the top of your table is bowed down and you get absolutely no flow of air."

## COMMERCIAL PREPARATION OF ANTHRACITE BY THE SAND FLOTATION SYSTEM

(*Continued from page* 416)

of the above questions has to do with the separating system used and is simply a question of sizing design and operation and of proper admixture of run of mine feed.

I am not prepared to say that in the steam sizes the sand flotation will give a cleaner product under similar conditions than any existing system but results show that, if proper shaker or screen area is provided to wash the rice and barley sizes free from sand, the Chance system reduces the incombustible in the steam sizes fully as low, with the same recovery, as any existing system. The percentage of ash in market coal which this reduction will result in is dependent on the inherent ash in the coal and the amount of boney material in the run of mine.

Most of the above opinions are based, as I have said, on reasonably efficient operation and design. It has taken 50 years to mechanically develop the anthracite jig to its present state of efficiency and it is not to be expected that the flotation installation has reached full mechanical development in 6 years time. The greatest danger to efficient separation comes from the presence of very fine coal or sludge in the separating cone, others from a too great accumulation of slate in the classifying column, a lack of feed control allowing overloading, concentration of low grade run of mine product in breaker feed and failure to eliminate sand from the small steam sizes of market product. These conditions are neither difficult nor impossible to control. Where they are controlled and the installation properly maintained and operated with average intelligence and attention, the average results indicated in this paper are being obtained.

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In the discussion following the presentation of this paper, Mr. Dorrance clarified his statement concerning the use of the air separation process in the anthracite field, stating that the methods he referred to were more or less mechanical picker, and not air concentrating tables, which have never been tried in this field on the prepared sizes. He said that the first mechanical separation of anthracite coal used air as a medium, using the slot type picker, and the friction type picker, all operating without water as a medium, depending entirely upon the different coefficients of friction between slate and coal, and also the difference of the specific gravity of the slate and coal dropped in air as a medium as against water. The mechanical picker has been abandoned in the anthracite region.

## CLEANING ANTHRACITE BY THE LAUNDER SYSTEM

(*Continued from page* 424)

rado. The installation was originally one with three discharge launders. That was put into operation last fall and worked continuously until about March at which time an additional set was added, doubling the capacity of the plant.

"Weights were taken on a weightograph and taken also by an automatic sampler. We took a cut across a seam of coal so that the results in the average are very accurate. Taking the average of the results the coal can be crushed down to 5/16. The average content of the coal as mined runs from 17 to 20 percent ash. Taking a typical screening test from the raw material, the material over 1/16-in. would run about 17 percent. The 16 to 48 mesh would run about 18 percent and the material under 48 mesh would be about 20. The very fine coal contains good value, which is different from a great many coals. The result of washing on the average would be something like this: 17 percent, on the material over 1/16, down to 8½, from 18 down to 9.2 on the 16 to 48 mesh and the material under 48 mesh would be about 15 to 16. The refuse has run from 49 to 53 percent ash.

"The results as compared with the washability curve prepared from weeks of test is a pretty good average on the washed coal running from ¾ of 1 percent to 1½ percent, that is in ash above the ash shown in the curve for the actual recovery. If the curve showed 9 percent we would get between 9¾ and 10½. That feed varies from 16.3 up to 20. With that variation of feed they are able to hold their ash quite uniform."

In answer to an inquiry concerning comparative costs, ***MR. GUY V. WOODY,*** *American Rheolaveur Corporation, Scranton, Pa., said:*

"We have operated since October 13 of last year and up to the present time the maintenance cost, exclusive of an hour a day which they allow the operators free for tightening bolts, has been the cost of one propeller for the purpose of handling the recirculation, and about 150 pounds of sheet lining in one of the troughs.

"The labor cost in this plant, which has treated as high as 4,000 tons a day, is 2 men on the launders and 1 man tending the streams, 1 man tending some valves up at the top which is occasioned by the fact that they have no settling chamber. We have made a number of estimates, of course, on Rheolaveur plants and have compared them with jigs. They have indicated a saving of around 50 percent of the first cost. In some cases it has been more and in some cases it has been less. These are the only figures we have. The plant at Loomis has a shaft that was put in the old breaker. The cost of both was about $100,000 to $150,000 for the entire plant, which included the tearing out of considerable amount of old machinery and buildings. The Pardee plant, which handles 1,500 tons per day cost in the neighborhood of $125,000, which I believe was $75,000 less than they figured they could install the jigs for.

"The power at Loomis is 8,700 k. w. per ton of coal per hour. In other words, the plant was designed for around 300 tons per hour, I believe, and the total actual load, measured by meters is something under 300 k. w. It is more nearly around 250."

# PREPARING COAL BY TABLE WASHING METHODS

***Performance And Operation Of Tables In The Collieries of Lehigh Coal & Navigation Company Described—Problem At This Property One Of Manufacturing As Well As Mining—Comparative Data On Cost Per Ton For Cleaning Fine Coal With Jigs And Tables Given***

*By* R. E. HOBART*

IN DISCUSSING table operation of anthracite, we will limit our discussion to the performance and operation of the tables in the collieries of the Lehigh Coal & Navigation Co., and particularly in the new Lansford Breaker completed for the Lehigh Coal & Navigation Co. in 1926.

It might be well to explain some of the problems confronting the Lehigh Coal & Navigation Co. in the manufacture of anthracite for the market, as anthacite is not only a mining but also a manufacturing process. The coal veins at present mined by the company extend, from the Schuylkill River on the west, east for a distance of approximately 14 miles. They lie in a canoe-shaped basin outcropping on the sides of the mountains to the north and south. The average thickness of the main vein is 50 ft., and in some places as much as 100 ft. thick. The pitch of the vein on the north mountain is about 45 degrees, the vein extending to about 2,000 ft. below the surface of the valley. On the south mountain the pitch of the vein runs from 73 to 88 degrees. These veins have various partings of slate from 4 to 18 in. thick, and the mining is done by either the chute or breast method, and the material from the veins is loaded into mine cars by gravity. No gobbing of rock or slate can be done in the mines, the result being that special facilities are required on the outside to handle the excess amount of refuse. At one of our operations we dump on our refuse banks 40 percent of the run of mine material. The specific gravity of the coal ranges from 1.5 to 1.9.

In mining the thick veins in the Panther Creek Valley, only a certain proportion of coal may be taken out on the first mining, and at many of our operations we have remined the same vein three different times, the result being an increased amount of refuse with each mining.

Previous to 1922 jigs and cone washers were used to reduce the ash content in the fine sizes of coal prepared for market, and although these various methods helped to reduce the ash content of the coal, the cost of installations and the yearly upkeep, plus an increased demand for a lower ash product, causing greater difficulty in maintaining a low percentage of combustible in the refuse discharge, compelled us to look for a more satisfactory method of cleaning. About 1918 we experimented with a concentrator table, which proved to be a total failure. In 1922 we erected the new Coaldale Breaker, and installed six concentrator tables to be used on sludge. Sludge is the material which goes through a 1/16-in. round mesh into a hydro-separator, where the material from 100 mesh and larger is precipitated into the bottom of the hydro-separator, and is elevated and distributed to the various tables for cleaning.

In 1923 we installed a number of tables on No. 1 and No. 2 buck at our Nesquehoning Breaker. After considerable experiments and adjustments these tables were made to operate very satisfactorily, and we found that one of the important advantages in the use of tables was that all phases of the cleaning operation were at all times visible to the operator, and this not possible in any other process. The data derived from these installations decided us to use the table method for cleaning Nos. 1, 2, 3 and 4 buck coal, corresponding to buck, rice, barley and birdseye at Lansford Breaker.

These coal-washing tables consist of a wooden deck covered with linoleum or rubber. For the smallest size of coal, such as No. 4 buck, linoleum is used, but a rubber-covered top is used on the Nos. 1, 2 and 3 buck tables. On the top of the linoleum or rubber cover, narrow riffles of hardwood or molded rubber are nailed to the top. These riffles start from the head motion end of the table and run in a direct line parallel with the motion of the table, terminating on a diagonal line near the refuse end. The riffles are ¼ in. wide and taper from ⅝ in. in height at the motion end to about 1/16 in. at the refuse end. The spacing of the riffles depends upon the size of coal to be treated. For No. 1 buck the centers of the riffles are placed 1¾ in., No. 2 buck 1½ in. and Nos. 3 and 4 buck 1/14 in.

There are three important factors to be considered in the installation of tables:

1. The foundation.
2. Method of feeding.
3. Adequate water supply.

Disregarding any of the above important factors will mean an unsatisfactory table installation.

### INSTALLATION OF TABLES IN WOOD OR STEEL STRUCTURES

Tables should be placed on concrete piers built integral in the concrete with a 5-in. thick reinforced concrete floor. Reinforced concrete floors are laid on steel beams, supported on wood columns. Floors should be reinforced with heavy hyrib, which serves also as a form, and ⅜-in. reinforcing rods running both ways on 12 to 16-in. centers. Reinforcing rods should be turned up into piers to tie same to the floor. The installation of the tables in a steel structure should be made as above, except that the floor beams should be supported on the steel columns.

### FEED

The various sizes of coal, after leaving the screens or shakers, should go into storage pockets, so that the table may be fed at a regular rate. All of our tables have individual storage pockets before each table, and a chute or launder is used to each table feed-box.

### WATER

An adequate supply of water must be fed to the tables constantly, preferably from a static head, so that the table may be fed with a constant supply.

If the above-mentioned factors are guarded in the installation of the tables, a satisfactory separation may be accomplished.

As the feed of screened coal enters on the table it stratifies according to its size and specific gravity. The coal being the lightest, it is readily washed over the riffles into the washed coal launder. The heavy slate and foreign matter settles between the riffles and by the action of the head motion is moved toward the refuse end. As some coal tends to follow the refuse on the table, dressing water from the water launder flowing across the table removes this coal and carries it to the washed coal launder.

The tables for handling No. 1 buck at Lansford Breaker are reciprocated at a speed of 275 r. p. m., with a stroke of ¾ in. The table has an end pitch of ⅜ in. per foot, and a cross pitch of ¾ in. per foot. These tables have a dewatering screen attached on the coal end of the table, which dewaters the coal before going into the pocket.

To handle No. 1 buck coal, which is coal through a ½-in. round mesh and over a 5/16-in. round mesh, there are installed at Lansford Breaker six tables. With a feed of 9.93 tons per hour per table, having an ash content of 28.16 percent in the incoming feed, we reduce the ash content to 10.90 percent and use 150 gallons of water per minute; one man operates six tables.

Table I is a table test made on May 6, 1927, by our research department.

**TABLE I**
**Concentrating Table Test**

Lansford Colliery—Lehigh Coal & Navigation Co.
Size—No. 1 buckwheat. Through ½ in., over 5/16-in. round mesh
Date of test—May 6, 1927

| Section | Length of section inches | Gross tons per hour | Percent Prepared coal | Percent Ash |
|---|---|---|---|---|
| 1 | 33 | 1.57 | 20.91 | 7.65 |
| 2 | 33 | 2.05 | 27.30 | 9.27 |
| 3 | 33 | 1.52 | 20.24 | 10.89 |
| 4 | 33 | 1.08 | 14.38 | 10.87 |
| 5 | 33 | .86 | 11.45 | 14.57 |
| 6 | 30 | .43 | 5.72 | 23.40 |
| Average ash on entire coal end of table.. | | | | 10.90 |
| Average ash on entire refuse end of table. | | | | 81.77 |
| Average ash in feed..... | | | | 28.16 |

| | Coal | Refuse | Feed |
|---|---|---|---|
| Tonnage per hour..... | 7.51 | 2.42 | 9.93 |
| Water consumption, 150 g. p. m. | | | |

To handle No. 2 buck coal, which goes through a 5/16-in. round mesh, and over a 3/16-in. round mesh, there are installed six tables. With a feed of 9.93 tons per hour per table, having an ash content of 27.03 percent in the incoming feed, we reduce the ash content to 10.58 percent and use 116 gallons of water per minute. The speed of the table and the stroke are the same as

* Mechanical Superintendent, The Lehigh Coal & Navigation Co., Lansford, Pa.

that used for No. 1 buck. However, the end pitch is less, being about ¼ in. per foot and the cross pitch about ⅝ in. per foot. The coal from these tables is dewatered on screens attached to the table, while the slate end is dewatered in classifiers; one man operates six tables. One Model "D" Dorr Classifier 6 ft. wide by 18 ft. long dewaters the refuse end from six tables.

Table II is a table test made on April 27, 1927, by our research department.

**TABLE II**
**Concentrating Table Test**

Lansford Colliery—Lehigh Coal & Navigation Co.
Size—No. 2 buckwheat. Through 5/16 in., over 3/16-in. round mesh
Date of test—April 27, 1927

| Section | Length of section Inches | Gross tons per hour | Percent Prepared coal | Percent Ash |
|---|---|---|---|---|
| 1 | 33 | .78 | 10.91 | 6.94 |
| 2 | 33 | 1.92 | 26.84 | 8.50 |
| 3 | 33 | 2.16 | 30.22 | 10.00 |
| 4 | 33 | 1.18 | 16.51 | 11.17 |
| 5 | 33 | .61 | 8.53 | 15.46 |
| 6 | 30 | .50 | 6.99 | 19.63 |
| Average ash on entire coal end of table.. | | | | 10.58 |
| Average ash on entire refuse end of table. | | | | 70.57 |
| Average ash in feed..... | | | | 27.03 |

| | Coal | Refuse | Feed |
|---|---|---|---|
| Tonnage per hour..... | 7.15 | 2.78 | 9.93 |
| Water consumption, 116 g. p. m. | | | |

For treating No. 3 buck coal, which is coal screened through a 3/16-in. round mesh and over a 1/16-in. round mesh, there are installed six tables. With a feed of 7.74 tons per hour per table, having an ash content of 26.71 percent in the incoming feed, we reduce the ash content to 12.56 percent and use 82 gallons of water per minute. Those tables are reciprocated at a speed of 275 r. p. m., with a stroke of ¾ in. The end pitch of the table is 3/16 in. per foot, and the cross pitch is ½ in. per foot. The coal from these tables is dewatered on screens attached to each table, but on account of the fineness of the coal this is not satisfactory, and, in my opinion, a classifier should be used for dewatering this coal before entering the pocket; one man operates six tables. The refuse or slate end is dewatered in a classifier 6 ft. wide by 18 ft. long, one classifier handling the total refuse for the six tables.

Table III is a table test made on May 2, 1927, by our research department.

**TABLE III**
**Concentrating Table Test**

Lansford Colliery—Lehigh Coal & Navigation Co.
Size—No. 3 buckwheat through 3/16 in., over 1/16 in. round mesh
Date of test—May 2, 1927

| Section | Length of section Inches | Gross tons per hour | Percent Prepared coal | Percent Ash |
|---|---|---|---|---|
| 1 | 33 | 0.444 | 7.82 | 8.19 |
| 2 | 33 | 1.048 | 18.45 | 9.86 |
| 3 | 33 | 2.210 | 38.91 | 11.68 |
| 4 | 33 | 0.675 | 11.88 | 13.37 |
| 5 | 33 | 0.923 | 16.25 | 15.59 |
| 6 | 30 | 0.380 | 6.69 | 21.68 |
| Average ash on entire coal end of table.. | | | | 12.56 |
| Average ash on entire refuse end of table. | | | | 65.77 |
| Average ash in feed..... | | | | 26.71 |

| | Coal | Refuse | Feed |
|---|---|---|---|
| Tonnage per hour..... | 5.68 | 2.06 | 7.74 |
| Water consumption, 82 g. p. m. | | | |

To treat the material known either as No. 4 buck or sludge, as in this breaker we make either size, there are installed 12 tables. This coal, which goes through a 1/16-in. round mesh, enters a 24-ft. hydro-separator, which was estimated to handle a flow of 4,000 g. p. m., having 100 tons of solids per hour. A considerable portion of coal and refuse from 100 mesh and smaller is overflowed and flows into a 100-ft. Dorr thickener. In the overflow pipe from the hydro-separator to the Dorr thickener is installed a liming apparatus, which is used to neutralize the acid water. This has worked very satisfactorily.

The percipitated coal from the hydro-separator is elevated to the top of the No. 4 buck or sludge plant, where it is distributed into a tank 4 ft. in diameter by 6 ft. deep, having around its periphery at the bottom of the tank twelve 2-in. diameter holes, each hole feeding into a launder through which the feed gravitates to a table.

With a feed of 5.24 tons per hour per table, having an ash content of 23.28 percent, we reduce the ash content to 13.69 percent and use 65 gallons of water per minute. These tables are reciprocated at a speed of 275 r. p. m., with a stroke of ⅝-in. The table has an end pitch of ⅛ in. and a cross pitch of ⅜ in. per foot. The coal from these 12 tables is dewatered in six 5½ in. by 18 ft. classifiers. One classifier handles the coal from two tables. The slate or refuse from these 12 tables is handled in two 4½ in. by 18 ft. classifiers, or one 4½ ft. classifier handles the slate or refuse end from six tables. One man operates 12 tables.

Table IV is a table test made on April 4, 1927, by our research department.

**TABLE IV**
**Concentrating Table Test**

Lansford Colliery—Lehigh Coal & Navigation Co.
Size—No. 4 buckwheat through 1/16 in. round mesh, retained on 100 square mesh
Date of Test—April 4, 1927

| | Percent |
|---|---|
| Average ash on entire coal end of table.. | 13.69 |
| Average ash on refuse coal end of table.. | 41.77 |
| Average ash in feed..... | 23.28 |

| | Coal | Refuse | Feed |
|---|---|---|---|
| Tonnage per hour..... | 3.45 | 1.79 | 5.24 |
| Water consumption, 65 g. p. m. | | | |

From our operating experience with jigs compared with tables we have some figures which will be of interest. The following is a comparison showing our cost per ton for cleaning fine coal with jigs and tables:

| | Jigs | Tables |
|---|---|---|
| Maintenance and operation... | $0.0360 | $0.0127 |
| Power ..... | .0047 | .0015 |
| Depreciation ..... | .0020 | .0120 |
| Water supply..... | .0026 | .0013 |
| Total..... | $0.0653 | $0.0278 |

## SAFETY MEASURE SIGNED

Dusting or use of other incombustible material in gaseous bituminous mines of Pennsylvania is required where entries are driven more than 105 ft., without the formation of an air circuit, under provisions of the Rieder Bill, approved by Governor Fisher.

In mines using other than the "room and pillar" system, bill provides that sufficient air be circulated to render harmless all smoke, noxious and explosive gases; that in gaseous mines an improved safety lamp shall be kept at every working place which is more than 105 ft. without a cut-through; that such a place shall be examined at least three times daily by a mine official, and that Government approved, flameproof electric motors shall be used for booster and blower fans.

## CLEANING OF SMALL SIZE BITUMINOUS COALS

(*Continued from page* 418)

into the second and the second into the third and so on, and the last overflow was easily controlled. But in case of emergency if it did overflow it would go back to the settling tank through which the coal is obtained. So there is absolutely no loss of coal in any way.

"Another difficulty is in designing a plant. You want to be sure that for a given coal you have the proper sized pump. I should say a pump with the proper capacity. I think my associates will bear me out in this that the average pump manufacturer does not know the capacity of his own pumps for handling a mixture of solids and water. The tendency is to assume that the capacity of this pump for this mixture will be the same as the capacity for water. It is not. There are, I suppose, three companies, perhaps more, who know this subject so that they will not go wrong in this respect. These are the people who manufacture sand and dredging pumps. Our experience has been that they over-estimate the capacity of the pumps for this purpose almost 100 percent.

"Luckily in the plant which was just started in operation at the Colliery of the Philadelphia and Reading, we had provided almost that much excess capacity. We are running pretty close to the margin and we are changing the pumps a little to get a little more capacity in order to keep the material in suspension. I might say that this installation employs 5-ft. square tanks, 25 ft. of area to each tank. There are three stages to it and there is a 3-compartment jig. In our cleaned coal there is about 1 percent finer than a 60 percent mesh. Incidentally this coal will drain to about 8 or 9 percent moisture with that much slime.

"The feed to this plant is running approximately 25 percent ash and a cleaned coal between 11 and 13 percent. It was hoped that it would be below 15 percent ash. So there is still a possibility of increasing the capacity by raising the ash in the cleaned coal. The capacity of the 5-ft. tanks is approximately 25 tons per hour of cleaned coal at this plant. This is somewhat more than we had anticipated. We thought it would be around 18 or 20. So that our plant is over capacity for the breaker apparently. We have not been running it long enough to get operating data beyond what I have mentioned.

"This plant occupies a place approximately 27 ft. long by about 9 ft. wide and 14 ft. high. There is one problem still to be solved. That is in the classifier used for cleaning coal, whether the area of the tanks or the depth of the overflow has the greater influence in producing tonnage and clean coal. We have not yet decided which it is. Both have a certain influence but which has the greater influence we do not yet know.

"When there is an overflow over the one side of a square, one side is used to produce the circulation through the pump. That brings up a point often raised as to why we should take clean coal off the top and put it right back in the bottom again. The only answer we can give is that we clean the coal in spite of the fact that we do that. We do it to maintain a uniform upper current and to get a classified area over the full flow of the tank."

# PREPARATION AND MARKETING CROP LINE AND OFF-GRADE COALS

*Crop Coal Softer—Principal Necessity Is To Keep Down Moisture And Ash—Zinc Smelters Use Very Soft Product, Cement Plants Slightly Harder Coal—High Sulphur Coal Must Be Crushed Or Screened*

By W. C. SHANK *

DISCUSSION of Crop Line and Off-Grade Coals is somewhat unusual, in the light of the tendency to emphasize, through the medium of advertisement and salesmanship, the value of quality coals, properly prepared. Trade-marking and other means of identification of coal is no doubt bringing about increased sales, when coal is uniform in character and preparation. The marketing of crop line and off-grade coals presents a definite problem to operators who have this class of product to sell. The problem is to find a market where this class of coal can be efficiently used. I believe that this character of coal has a definite place in the coal market today, even though the name implies inferiority. Certainly the operator who experiences this character of product has a real interest in creating a market which will absorb the kind and character of coal he produces, in spite of the fact that it is admittedly deficient for domestic or ordinary commercial usage.

Most of us are familiar with the fact that crop line coal is usually of softer nature than coal from the same seam under greater depth of cover, and protected from the effect of infiltration and exposure by slate and other stratified rock formations. Crop line coal usually carries a high percentage of moisture; relatively low ash content, and is usually non-coking.

The principal markets we have found for crop line coal are zinc smelters and cement plants. The softer variety of crop line coal has been used, efficiently, at zinc smelters. The main items to be watched in the preparation of satisfactory smelter coal are:

*First.* The coal should be loaded dry to keep down the moisture content, which is inherently excessive.

*Second.* The coal should be loaded clean and free from dirt, to keep the ash content to the minimum.

Usually the percentage of sulphur is very low in this class of coal. Any tendency for the coal to coke is detrimental for smelter use. Smelter or dead coal obtained from out-croppings, when received at the smelter, is ground to a size which will permit thorough drying, to drive off the moisture content. An average analysis of dry dead coal approximates

| | |
|---|---|
| Volatile | 35% |
| Fixed Carbon | 60% |
| Ash | 5% |

if the coal has been loaded clean. To improve the quality is to increase the carbon by decreasing the ash, as the carbon is the desirable factor, inasmuch as the coal is used as a reduction agent. The dried coal is charged with roasted zinc ore (zinc oxide), into retorts, where the chemical action of reducing the zinc oxide into metallic zinc is obtained.

Crop line coals of little harder nature, and usually found at greater distance from the actual out-crop, which are characterized as shelly coal, have given very satisfactory results in the burning of Portland cement. Again, as in the case of preparation and loading of smelter coal, it should be loaded dry and clean to keep the moisture and ash content to the minimum. The process through which the coal is put for cement burning, I quote from a chemist of a prominent cement company in the Southwest:

"Coal to be used for cement manufacture is passed through a crusher of the roll type. Then through an indirect fired rotary dryer, which removes the mechanical moisture but not the combined moisture. The dried coal is then passed through a Raymond mill. Ninety to ninety-five percent of the product from this mill ordinarily passes the 100-mesh sieve. The coal is now ready to be brought into the firing zone of the kilns. We maintain a very high temperature in the burning zone of the kiln, 2,500° to 3,000° F. Burning cement clinker consists almost entirely of raising it to the clinkering temperature, so in addition to total heat we must have flame temperature. Moisture in coal lowers the flame temperature a great deal. Sulphur is objectionable for two reasons. *First.* Because it affects the quality of the cement if present in too large quantities, and, *second*, because it combines with the lime to form slag. Ash is of less importance, as a part of it combines with the mix to form clinker."

Our crop line coal of the harder or shelly variety has found a satisfactory market in the cement plants, which use this product much more efficiently than it could be used under a boiler for steam making, on account of its lightness.

The two most common classes of off-grade coal which we encounter in Kansas are: *First.* The stained or discolored coal, found in strip mines, and, *second*, the hard snarly sulphur coal, containing an excessive amount of pyrites, usually as sulphur ovals or bands. The discolored coal is oftentimes a very satisfactory domestic product, but its discoloration (red to brown) creates a prejudice by the domestic coal dealer unfamiliar with it. We have had satisfactory experience in marketing this character of coal for industrial use, rather than domestic, as the fact that it is discolored has not always impaired its heat value. Fine sizes are sold for power plant use and the coarser sizes also for industrial steam purposes, such as steam locomotives around industrial plants, etc. The off-grade coal of the excessive sulphur variety, of course, is not a satisfactory domestic fuel. Neither is it a satisfactory industrial fuel, as long as the high percentages of pyrites are contained in it. We have obtained best results by running this coal through a single roll spring crusher, which breaks the coal away from the sulphur ball or slab, and then screening the resultant product, making the grades of nut and screenings; the sulphur passing over the nut screens and thrown away. Where excessive sulphur content is found of a softer and seamy nature, we have crushed this coal to stoker size and sold it to steam plants using large quantities of coal and purchasing same on a B. T. U. basis, thereby disposing of the product solely on the basis of its heat value.

I presume these remarks are more or less familiar to all of you, and I have merely attempted to state some of our experiences with the class of product we have had to deal with, under the classification—"Crop Line and Off-Grade Coals"—about which your committee had asked me to make a few remarks.

* President, The Carbon Coal Co., Pittsburg, Kans.

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Wm. C. Atwater, president of Wm. C. Atwater & Company, of New York City, was reelected president of the Pocahontas Operators' Association at its annual meeting in Bluefield on May 12. The association also reelected James Ellwood Jones, vice president, Pocahontas Fuel Company, of Switchback, W. Va.; John J. Lincoln, general manager, Crozer Coal & Coke Company, Elkhorn, W. Va., and W. E. E. Koepler, of Bluefield, W. Va., as vice president, treasurer and secretary, respectively.

At the annual dinner in the evening, at the West Virginian Hotel, attended by over three hundred, Mr. Atwater was the toastmaster, and in a reminiscent mood he told of early days in the Pocahontas field. Mr. J. G. Bradley, president of the West Virginia Coal Association and president of the Elk River Coal & Lumber Company, of Dundon, W. Va., in speaking on "The Bituminous Industry of West Virginia," referred to the solidarity that now exists between operators, miners, business and professional men in the mining communities and those dependent thereon, estimating that more than half of the population of West Virginia is a part of this industry population. Executive Secretary Gandy, of the National Coal Association, spoke on the general trade association movement as an aid to progress in an industry where competition exists not only within the industry but with other industries.

The Smokeless Coal Operators' Association, Maj. L. Rodman Page, treasurer, Crozer Coal & Coke Company, Philadelphia, Pa., president, and E. J. McVann, of Washington, D. C., secretary, met on the afternoon of the 12th. Routine business was transacted, and those in attendance were guests at the Pocahontas dinner.

# CLEANING COAL BY THE WET JIG PROCESS

*Problems Of Jig Operation — Varying Factors Of Jig Efficiency — Pitching Seams Increase Quantity Of Slate To Be Removed — Total Costs Of Cleaning Enumerated — Anthracite Production Being Constantly Improved In Quality*

*By* E. E. FINN*

THE term "Wet Jig Process" is sometimes used by engineers as including any method of removing impurities from coal where water is used. In this discussion, however, "Wet Jig Process" will be considered as only applying to equipment commonly known as jigs and utilizing the principle of intermittent upward flow of water. The data presented will apply only to the cleaning of anthracite.

During the past decade several good treatises have been written on the details of jig performance, hence I will not discuss that phase at this time. These treatises, generally, described the jig as being superior to other methods and used in cleaning a vast percentage of all coal produced, which is still true today. New types of jigs and other coal-cleaning equipment have been, or are being, perfected. If we are progressive, we should thoroughly investigate them; however, we should not forget the proper consideration of our reliable friend the "jig." Is the jig giving us the most efficient results; if not, have we given it a fair show?

We have seen a new jig installed from time to time. It is in the limelight for a period, during which it has the care of the best mechanics, the best operator and quite frequently two or more representatives of the company which produces it. Wonderful results are generally obtained and are compared with data from general operating units which have little care and often not in the best repair. A few points frequently overlooked in jigs are:

Worn plunger, loose grates, improper pitch of grates and feed gate, opening of feed gate, length of stoke and speed. No adjustment should be made to any part of a jig without first considering its relation to other parts, otherwise a neutralizing effect may result.

Points of major importance and given little attention, are:

*First*—Height of slate bed affects capacity due to weight to be lifted and has a very important part in eliminating impurities. It is sometimes stated that flat slate can not be removed in jigging process. This is absolutely untrue if the jig is given proper attention. A fairly high slate bed will cause flat slate to turn on end as it passes under the feed gate and in this position is easily removed.

*Second*—Lack of uniform feed to the jigs affects separation. Frequently it is the custom to provide a small storage pocket above the jigs, but it is very rarely that this is sufficient as the tonnage of coal dumped varies not only per day but during any hour. Due to this condition the adjustments are set to meet the maximum demand, hence a large part of the time are working under a small or no load so that water splashes in the jigging compartment causing a loss of slate bed or a discharge of flats into the coal. Some jigs are provided with clutches and can be stopped when there is no feed, but it is better practice to be operating continually and efficiently at an average load. An increase in tonnage per day may be handled in this manner. Sometimes an excuse is offered that there is not sufficient height for a storage pocket. A shaking chute requires less pitch than the gravity and may provide the required space in some cases.

The cleaning of coal by "wet jig process" usually provides for sizing of coal before jigging, each size being cleaned by several jigs. This method has a distinct advantage in that, when one jig is down for repairs through some accident, the production of the breaker is not greatly impaired. A process which provides for cleaning mixed sizes, if out of adjustment, may condemn or delay a major portion of production. A mine is not usually provided with sufficient cars to continue mining if the breaker stops.

In determining the operating efficiency of a jig, we must consider capacity, amount of impurities in the raw feed, the percent of impurities in the finished coal discharge and the percent of coal and good bone in the refuse discharge. These factors are of varied importance depending upon the mining conditions. In the northern and middle anthracite fields the veins are comparatively flat, thus permitting the loading of slate and coal separately, while in the southern field the veins are generally on a very pronounced pitch, necessitating the loading of slate and coal together. This condition brings the amount of impurities in the raw feed to the jig as high as 45 percent in many cases, compared to 10 to 15 percent in northern and middle fields. Hence in stating capacities of jigs, the tonnage feed should be used and costs per ton computed on this basis for comparison of jig performance as between the various fields. This high percentage of impurities in the feed also brings into a place of utmost importance the quality of refuse discharged from a jig. One percent of coal in refuse at 45 percent is equivalent in weight to 3 percent coal on basis of 15 percent refuse in feed, hence the necessity of maintaining, as near as possible, a pure refuse in the southern field.

No. 1 buckwheat size was used due to ease of handling in float and sink apparatus. The 1.9 solution was made up by mixing zinc chloride with hot water. The two columns marked "Cumulative Percent Coal" are in reverse order so that totals of any gravity can be read directly.

It is noted that the coal varies from 1.5 to 1.84 and that 11.53 percent floats at 1.7, the gravity generally used in sand flotation process. The cumulative ash on coal floating at 1.9 was 10.07 percent, hence in a process of cleaning coal by a gravity flotation it would be necessary to use a gravity of not less than 1.9. This, I believe, is difficult to reach with sand solution, but can be met by a fine ore solution.

As the question of importance to any operator is, "What does the cleaning of coal cost our company?" Table II is given. The breaker where figures were collected was in its fourth year of operation in 1926, hence the figures are representative.

The quality of the commercial coal at the present time is somewhat improved over the figures shown, as all anthracite companies are following the trend of an improved product to the consumer. One or two producers of coal cleaning equipment claim for their process a coal discharge practically free of impurities. This can be accomplished by "wet jig process" also by reducing the capacity and increasing slate bed yet still maintain a low percent of combustible in the refuse discharge. But is it a kindness to the consumer to give him a coal entirely free of impurities? I know of an instance where a small car of stove coal containing 0.75 percent of slate and 1.0 percent bone was shipped to a director of a coal company. He called it the poorest car he ever received, stating that it had no life and asked for another car. The next car contained 3.0 percent slate and 2.5 percent bone and was reported to be an excellent car. Furnaces today are rated on coal formerly burned, and usually in domestic use a man will not realize the saving in fuel necessary to

TABLE NO. 1—FLOAT AND SINK (Gravity) SEPARATION ON L. C. & N. CO. COAL

| Gravity solution zinc chloride | Raw feed percent | Percent coal | Cumulative Percent coal | Cumulative Percent coal | Percent Ash | Percent Ash Cumulative |
|---|---|---|---|---|---|---|
| +1.90 | 31.60 | | | | 85.27 | |
| 1.84 | 1.67 | 2.44 | 99.94 | 2.44 | 39.85 | 10.07 |
| 1.80 | 1.54 | 2.25 | 97.50 | 4.69 | 34.07 | 9.33 |
| 1.76 | 1.12 | 1.64 | 95.25 | 6.33 | 30.68 | 8.74 |
| 1.73 | 1.34 | 1.96 | 93.61 | 8.29 | 26.54 | 8.36 |
| 1.70 | 2.22 | 3.24 | 91.65 | 11.53 | 22.89 | 7.97 |
| 1.68 | 1.40 | 2.05 | 88.41 | 13.58 | 18.58 | 7.43 |
| 1.66 | 1.12 | 1.64 | 86.36 | 15.22 | 16.12 | 7.16 |
| 1.64 | .33 | .49 | 84.72 | 15.71 | 12.63 | 6.99 |
| 1.63 | 3.65 | 5.34 | 84.23 | 21.05 | 18.16 | 6.95 |
| 1.61 | 6.52 | 9.53 | 78.89 | 30.58 | 11.43 | 6.19 |
| 1.59 | 6.52 | 9.53 | 69.36 | 40.11 | 9.02 | 5.48 |
| 1.57 | 7 82 | 11.43 | 59.83 | 51.54 | 7.05 | 4.91 |
| 1.55 | 16.94 | 24.77 | 48.40 | 76.31 | 5.27 | 4.41 |
| 1.53 | 14.60 | 21.35 | 23.63 | 97.66 | 3.29 | 3.58 |
| 1.49 | .39 | .57 | 2.28 | 98.23 | 1.88 | 6.34 |
| 1.49 | 1.17 | 1.71 | 1.71 | 99.94 | 7.82 | 7.82 |

* Director of Research, The Lehigh Coal & Navigation Co., Lansford, Pa.

TABLE NO. 2—TYPICAL ANTHRACITE BREAKER EQUIPPED WITH OVERFLOW JIGS—YEAR 1926—1,800 HOURS OPERATION

| | Egg | Stove | Nut | Pea | No. 1 Buck. | No. 2 Buck. | No. 3 Buck. |
|---|---|---|---|---|---|---|---|
| Commercial shipments, tons | 61,968 | 136,936 | 165,742 | 66,593 | 113,487 | 76,886 | 130,564 |
| Number of jigs | 3 | 5 | 6 | 3 | 4 | 2 | 2 |
| Commercial tons per jig hour | 11.50 | 15.21 | 15.35 | 12.33 | 15.76 | 21.36 | 36.26 |
| Percent slate in commercial coal | 2.7 | 3.7 | 4.5 | 7.0 | 10.0 | 12.0 | 15.0 |
| | | | | | 17.5* | 18.9* | 23.7* |
| Percent bone in commercial coal | 3 | 3.9 | 3.0 | ..... | ..... | ..... | ..... |
| Percent coal in refuse | 0.7 | 0.8 | 0.9 | 1.8 | 5.8 | 8.0 | 10.0 |
| Percent bone in refuse | 1.5 | 1.3 | 1.2 | ..... | ..... | 81.0* | 79.0* |
| Feed in tons per jig hour | 17.29 | 22.53 | 22.41 | 17.61 | 22.84 | 31.88 | 53.32 |
| Cost per ton of feed— | | | | | | | |
| Total tons feed | 93,366 | 202,770 | 242,028 | 95,094 | 164,448 | 114,768 | 191,952 |
| Operating labor cost | .0212 | .0163 | .0164 | .0208 | .0161 | .0115 | .0069 |
| Repairs and maintenance cost | .0134 | .0103 | .0103 | .0131 | .0101 | .0073 | .0043 |
| Total labor cost | .0346 | .0266 | .0267 | .0339 | .0262 | .0188 | .0112 |
| Maintenance material cost | .0130 | .0099 | .0100 | .0127 | .0098 | .0070 | .0042 |
| Total labor and material cost | .0476 | .0365 | .0367 | .0466 | .0360 | .0258 | .0154 |

* Ash.

| Summary | Total tons | Cost of jigging per ton | Power and repair cost per ton 15,000 G. P. M. pumping | Power cost per ton operating jig | Depreciation and interest on investment, 25 jigs | Total cost per ton |
|---|---|---|---|---|---|---|
| Commercial coal | 752,176 | .0491 | .0039 | .007 | .0072 | .0672 |
| Feed | 1,104,426 | .0335 | .0026 | .0047 | .0049 | .0457 |

These overflow jigs are of two compartment type, each compartment 24 sq. ft., hence equivalent to 50 single compartment jigs. Attendance includes 1 boss, 6 operators, 2 day machinists, 2 oilers and 4 night repairment. No hand picking necessary.

offset the increase in price charged for a pure coal.

Steamboat and broken sizes formerly hand-picked with the aid of tables and spirals, are now jigged by Wilmot type C jigs. Table No. 3 shows total cost per ton and is less than half the cost of old method.

TABLE NO. 3—PAN TYPE JIGG—YEAR 1926, 1,800 HOURS OPERATION

| | Steamboat | Broken |
|---|---|---|
| Prepared coal, tons | 68,400 | 75,600 |
| Number of jigs | 2 | 2 |
| Prepared coal per jig hour | 19 | 21 |
| Percent slate in prepared coal | 0.7 | 1.0 |
| Percent bone in prepared coal | 1.8 | 2.0 |
| Percent coal in refuse | 1.5 | 2.1 |
| Percent bone in refuse | 2.0 | 2.2 |
| Feed in tons per jig hour | 29.23 | 32.31 |
| Cost per ton of feed: | | |
| Total tons of feed | 105,243 | 116,309 |
| Operating labor cost | .0179 | .0162 |
| Repairs and maintenance | .0065 | .0058 |
| Total labor cost | .0244 | .0220 |
| Maintenance material cost | .0171 | .0155 |
| Total labor and material cost | .0415 | .0375 |

| Summary | Total tons | Cost of jigging per ton | Power cost per ton | Depreciation | Cost total |
|---|---|---|---|---|---|
| Prepared coal | 144,000 | .0481 | .0014 | .0057 | .0552 |
| Feed | 221,552 | .0313 | .001 | .0037 | .036 |

Attendants are—2 operators and 1 night machinist. No hand picking necessary.

The jigging of steamboat and broken sizes in addition to saving one-half the cost of the old method, also provides a definite mechanical separation as compared to the unreliable personal equation.

## COOPERATIVE RESEARCH FELLOWSHIPS OFFERED BY MINING SCHOOLS

EXCELLENT opportunities for training in methods of scientific research along mining and metallurgical lines are afforded by a series of fellowships offered by a number of leading educational institutions for work in cooperation with the United States Bureau of Mines, covering the educational year 1927-28. Students holding these research fellowships are assigned to assist in the solution of certain problems on which members of the technical staff of the Bureau of Mines are working, and the successful completion of their tasks makes them eligible for various degrees. Those receiving this highly specialized training are in considerable demand in the industrial world.

The Department of Mining and Metallurgy, College of Engineering, of the Carnegie Institute of Technology, Pittsburgh, Pa., offers eight fellowships in mining and metallurgical research, for work in cooperation with the Pittsburgh experiment station of the Bureau of Mines and advisory boards representing the mining and metallurgical industries. Fellowships are open to graduates of colleges, universities and technical schools, properly qualified to undertake research investigations. Each fellowship carries a stipend of $750. Fellowship holders become candidates for the degree of master of science.

The subjects which have been suggested for investigation include the coking constituents of coal, the oil and tar yields of coal, storage-battery locomotive in comparison with trolley-locomotive haulage in coal mines, blasting coal, and correlation of fusing temperature of coal ash with clinker formation in furnaces.

The Mackay School of Mines of the University of Nevada, Reno, offers one fellowship open to graduates of American mining colleges of recognized standing. The income of the fellowship is $750 per year. The holder will be assigned to research service with the staff of the Rare and Precious Metals Experiment Station of the Bureau of Mines.

Several fellowships, each having an annual net value of $720, are offered by the Department of Mining and Metallurgical Research, University of Utah, Salt Lake City. This department cooperates with the Intermountain Experiment Station of the Bureau of Mines. During the year 1927-28 the problems to be investigated include flotation, hydrometallurgy of zinc, hydrometallurgy of lead, pyrometallurgy of complex lead-zinc ores, differential sulphating of complex ores and concentrates to facilitate subsequent separation by milling or leaching, pyrometallurgy of lead.

The School of Mines of the College of Engineering of the University of Alabama offers five fellowships in mining and metallurgical research for work in cooperation with the Southern Experiment Station of the Bureau of Mines at Tuscaloosa, Ala. The fellowships, valued at $540 per year, are open to graduates of universities and engineering schools who have proper qualifications to undertake research and investigation. Fellowship holders become candidates for the degree of master of science. For investigation during the year 1927-28, fellows will study the beneficiation of low-grade bauxite ores, the beneficiation of phosphate rock, and float-and-sink treatment of Alabama coals.

The Arizona Bureau of Mines, a subdivision of the College of Mines and Engineering of the University of Arizona, Tucson, offers two fellowships in metallurgical and chemical research for work in cooperation with the Southwest Experiment Station of the Bureau of Mines. These fellowships are open to men who have obtained the equivalent of the bachelor of science degree from a recognized university or technical school, who have specialized in metallurgy or chemistry as undergraduates, and who are qualified to undertake research work. Each fellowship yields $660 for a period of 11 months, beginning July 1. For study during 1927-28, the following subjects have been selected: Physical properties of copper mattes at various temperatures, capillarity in heap leaching of copper ores, diffusion as a factor in copper leaching, oxidation and reduction of iron solutions in heap leaching.

# RECENT DEVELOPMENTS IN MECHANIZED MINING

*Development Of Equipment And Mining Systems—Conclusions Based On Observations Of Twenty-Seven Mechanical Operations—Loaders, Conveyors, And Scrapers Working Wide Range Of Coal Heights And Seam Conditions*

*By* G. B. SOUTHWARD*

THE recent developments in mechanized mining—which includes the use of mechanical loaders, scrapers and conveyors—can not well be described without first giving some thought to the beginnings of mechanized mining and to the beginning of its recent development. It is not generally realized by coal mining men that the first uses of these types of equipment date back for 25 years and during that time experiments were quietly carried on until about five years ago when the mining industry as a whole was awakened to the fact that there were loading machines and conveyor mining operations actually in use. There is perhaps no one thing that has ever happened in the history of coal mining which tends to refute the popular belief that this industry is unprogressive than the promptness with which mechanization developments were started with this new equipment. Unfortunately this action was premature and the many mechanical installations which were made at this time, without due realization of what their use involved and before the equipment had been mechanically perfected for the service it had to perform, had about the same result on the development of mechanized mining as the effect of throwing an armful of green wood on a small camp fire—it made a lot of smoke which got in every one's eyes and nearly put the fire out.

During this period the development of mechanization was along two general lines, one perfecting the mechanical designs and the other devising mining systems and methods for their use, and, in most instances, these two developments had to be made simultaneously. When we consider the difficulties and problems involved in trying to effect a saving in the mining cost by using equipment that had not yet been perfected and consider further that this equipment required entirely new operating methods which had to be determined and worked out, it is small wonder that mechanized mining at first made slow progress. In fact, it is a wonder that it made any progress at all. The failures which resulted from these first efforts were discouraging to those who had assumed that mechanical mining required nothing beyond the purchase of the necessary equipment and many loading machines and conveyors were abandoned after a brief period of attempted operation. But others kept on and those operators who have succeeded are those who early recognized the true situation and instead of expecting immediate results, started out with a clear understanding that an experimental period would have to be passed through before any real or satisfactory results could be had. It is by the experiences of these men in these operations that the coal mining industry as a whole can now profit by taking advantage of the things which they have learned, but this advantage can not be taken by blindly following and duplicating the successful methods. It must always be kept in mind that each of these operations has been developed along certain lines to meet certain requirements and we must know exactly what these and our own requirements are before we can determine whether or not their methods will apply.

The statements and conclusions in this article are based to quite a large extent on the observations made during the mechanization investigation undertaken by The American Mining Congress. At the present time, this survey has covered the bituminous fields in the eastern part of the United States but has not yet included any mines west of the Mississippi River; consequently when the survey is extended to the western fields the results observed there may perhaps change some of the conclusions that have now been formed. It should also be stated here that a brief trip through the anthracite fields of Pennsylvania has shown that there are quite a number of interesting and successful mechanical operations there, but since their methods and conditions are somewhat different from those in the bituminous fields, it is thought advisable to cover the anthracite mining by a separate report.

In the eastern bituminous fields including the states of Pennsylvania, Ohio, Indiana, Illinois, Kentucky, West Virginia, Virginia and Alabama, a total of 35 mechanical operations have been visited. Of these, six were still experimental, three were idle temporarily for reasons not connected with the mechanical mining and 27 were operating and were considered by their managements as being practicable and successful. These 27 do not include all operations east of the Mississippi but is believed that these are a sufficient number and that they are reasonably representative to show a fair average cross section of mechanical mining as it is being carried on successfully today. The accompanying table shows a compilation of the types of equipment used, methods of mining and character of the seams mined:

Summarizing the various types of equipment according to the uses in the different mining systems they are:

One room and pillar—mechanical loaders in entries, rooms and pillars.

Ten room and pillar—mechanical loaders in entries and rooms.

One room and pillar—mechanical loaders developing for retreating mining.

Two room and pillar—conveyor loading.

Two long face—conveyors on faces, mechanical loading in entries.

Four long face—Conveyors on faces, entries by hand.

Two long face—mechanical loader on faces.

Three long face—scrapers on faces, entries by hand.

Two entry development for special purposes.

***It would not be proper to publish this article or the mining reports which will follow without due acknowledgement to the coal operators and manufacturers who, by their help and cooperation, have made this investigation possible. At the various mines visited the writer was given permission to go underground to make personal observations and collect data, and the managements gave their personal assistance, as well as that of their organizations, to see that correct and full information was obtained and furnished. It is believed that these reports will be of value to the coal mining industry and their value lies in the fact that that they are records of a mining development which are being given to the industry by the men who made the development and progress.***

| System of Mining | Type of Mechanical Equipment and where used | Height of Seam | Amount of Partings | Percent of Output by Mechanical Mining |
|---|---|---|---|---|
| Room and Pillar | Loader in Entries, Rooms and Pillars | 9′ | Small | 40% |
| Room and Pillar | Loader in Entries and Rooms | 8′ | Small | 100% |
| Room and Pillar | Loader in Entries and Rooms | 6½′ | 2″ | 100% |
| Room and Pillar | Loader in Entries and Rooms | 7′ | Small | 100% |
| Room and Pillar | Loader in Entries and Rooms | 6′ | Small | 90% |
| Room and Pillar | Loader in Entries and Rooms | 5′ | Small | 100% |
| Room and Pillar | Loader in Entries and Rooms | 6′ | Small | 100% |
| Room and Pillar | Loader in Entries and Rooms | 7′ | 4″ | 100% |
| Room and Pillar | Loader in Entries and Rooms | 6′ | 6″ | 33% |
| Room and Pillar | Loader in Entries and Rooms | 5′ | 2″ | 16% |
| Room and Pillar | Loader in Entries and Rooms | 7′ | 4½″ | 95% |
| Room and Pillar | Loader in Entry Development | 7′ | 3″ | 25% |
| Room and Pillar | Conveyor in Rooms and Pillars | 4′ | Small | 10%* |
| Room and Pillar | Conveyor in Rooms and Pillars | 4′ | Small | 10%* |
| Long Face | Loader in Entries and Conveyor On Faces | 8′ | 12″ | 20% |
| Long Face | Loader in Entries and Conveyor On Faces | 3½′ | Small | 33% |
| Long Face | Loader on Faces | 5′ | Small | 90% |
| Long Face | Loader on Faces | 7′ | 4″ to 18″ | 40% |
| Long Face | Conveyor on Faces | 3½′ | Small | 75% |
| Long Face | Conveyor on Faces | 2½′ | 4″ | 100% |
| Long Face | Conveyor on Faces | 4½′ | 6″ to 22″ | 100% |
| Long Face | Conveyor on Faces | 6′ | 3″ | 15% |
| Long Face | Scraper on Faces | 7′ | 1″ to 8″ | 33% |
| Long Face | Scraper on Faces | 4′ | 6″ | 12%* |
| Long Face | Scraper on Faces | 4′ | 5″ | 75% |
| ..... | Loader in Entry Development only | 7½′ | 12″ | .... |
| ..... | Loader in Entry Development only | 7′ | Fault | .... |

* Operated less than one year: all others have operated more than one year.

* Mechanization Engineer, The American Mining Congress.

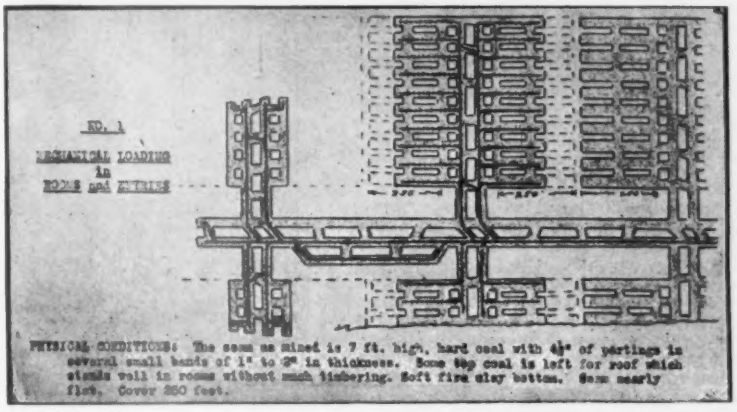
This summary shows that out of 25 mechanical operations, 14 are in room and pillar and 11 are in long face modifications of rooms and pillar or long wall. In the 14 room and pillar operations shown in the table, 12 are operated by mechanical loaders and two by conveyors and in the 11 modified or long face systems two are operated by mechanical loaders and nine by scrapers or conveyors. This seems to indicate rather definitely that for the present at least mechanical loaders are being directly substituted for hand loading without changing the mining system while the tendency in conveyor mining has been to develop a modified or long face system. It must be stated, however, that some of these modifications have been designed to suit certain physical conditions and probably would not succeed except under similar conditions and it is also necessary, in the interest of fairness and impartiality, to mention that long face mining has encountered some difficulties in its roof action and this has not yet reached a satisfactory solution in all cases. This is speaking generally as there are several examples where a satisfactory roof action has been attained. It is equally necessary, in the same interest of fairness and impartiality, to point out that mechanized mining in room and pillar work is not making a high pillar recovery—in most cases the pillars if recovered at all are mined by hand. This is again speaking generally as there are several exceptions to this where a high recovery is being made.

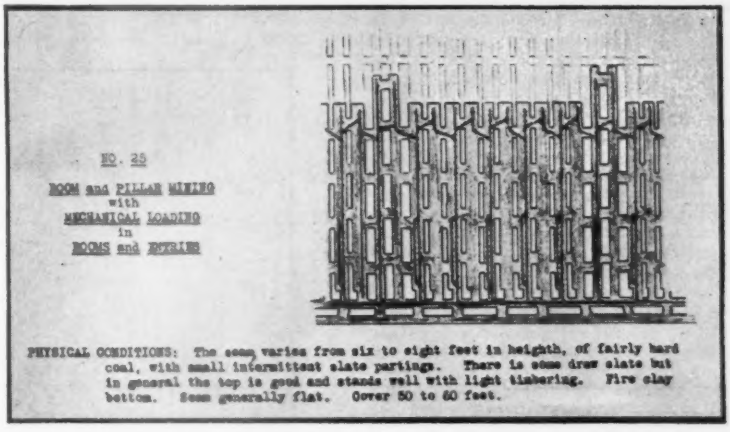
Summarizing the different types of equipment we find that there are 14 mechanical loading operations, eight conveyors and three scrapers. Since this table is showing the various methods of mining and does not take into account the number of machines or tonnage produced at each operation, this summary is not to be taken as indicating a comparison of the extent to which these different classes of equipment are being used. What this summary does show, however, is an interesting comparison as to the number of high and low seams operated by mechanical mining, since most mechanical loaders in this list are working in seams six feet high and over, while the conveyors and scrapers are for the most part employed in mining low coal where the seams are four feet and under. However, two of the 16 mechanical loading operations are in seams under six feet and three of the 11 conveyor and scraper operations are in seams over six feet and these exceptions may indicate a tendency to develop conveyors and mechanical loaders for both high and low coal. Certainly, it has not yet been accepted by the mining industry that the future mechanical loaders will be confined to high coal and that scrapers and conveyors will be confined to low coal.

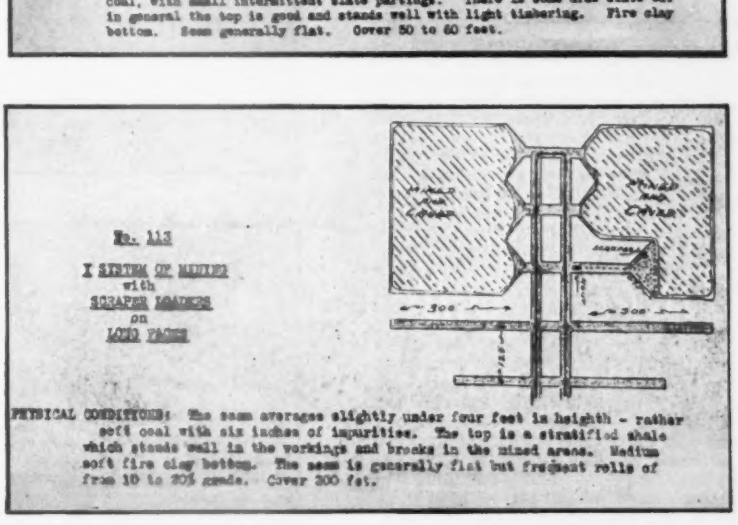
There are now actually two distinct lines of thought and endeavor; one which believes that mechanical loading will be developed to apply in all seams of coal—using conveyors, if they are to be used at all, solely as an auxiliary to the loaders—and the other opinion or thought being that conveyor mining—either with hand shoveling or with types of face conveyors designed to eliminate hand shoveling—will be developed with mining systems for all heights of coal and seam conditions. We find that each of these opinions are supported by men whose ability and experience qualifies them to speak with authority.

In these 25 operations 11 are mining seams that have no regular partings in the coal (although they all have some intermittent or irregular streaks of impurities), and 14 are mining seams that have bone or slate bands varying from 1 inch to as high as 22 inches—the average however being from 2 to 6 inches. Of these 14 seams with impurities, seven are mined by mechanical loaders and seven by scrapers and conveyors. This may perhaps justify us in assuming that dirt bands in seams have not been a factor in determining the type of equipment to be used.

In the last column of this table are figures showing the proportion of the total output at each of these mines that is being produced by mechanical methods. In the room and pillar mines the two conveyor operations are shown to be operating on a 10 percent mechanical basis and in the long face mines, one is shown to be operating by scrapers on a 12 percent mechanical basis. It is interesting to know that in these three mines the mechanical equipment has been in use for less than a year. In the remainder of the mines listed all have been operating mechanically for two years or more and we see that quite a number of these are producing by mechanical mining from 75 to 100 percent of the total mine output. This percentage will average higher in the room and pillar mines than in the long face mines and this shows that the development has been more rapid with mechanical loaders in the established systems where roof control is not a factor. It is certainly true that the tendency in the past has been


NO. 1
MECHANICAL LOADING
in
ROOMS and ENTRIES
PHYSICAL CONDITIONS: The seam as mined is 7 ft. high, hard coal with 4½" of partings in several small bands of 1" to 2" in thickness. Some top coal is left for roof which stands well in rooms without much timbering. Soft fire clay bottom. Seam nearly flat. Cover 250 feet.

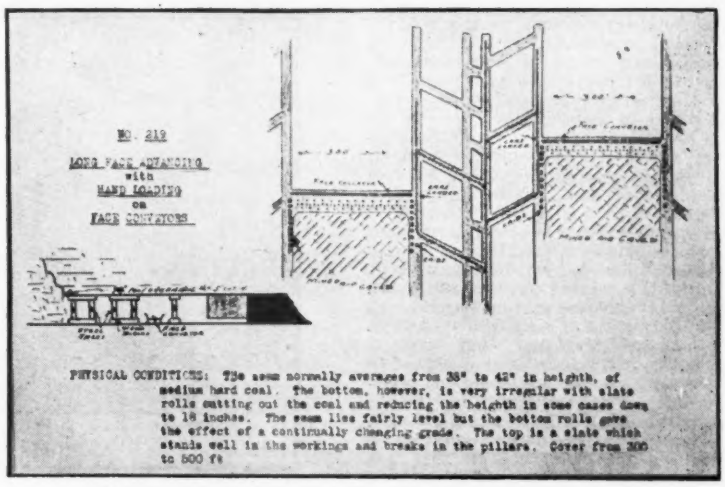

NO. 25
ROOM and PILLAR MINING
with
MECHANICAL LOADING
in
ROOMS and ENTRIES
PHYSICAL CONDITIONS: The seam varies from six to eight feet in heighth, of fairly hard coal, with small intermittent slate partings. There is some draw slate but in general the top is good and stands well with light timbering. Fire clay bottom. Seam generally flat. Cover 50 to 60 feet.


No. 113
I SYSTEM OF MINING
with
SCRAPER LOADERS
on
LONG FACE
PHYSICAL CONDITIONS: The seam averages slightly under four feet in heighth - rather soft coal with six inches of impurities. The top is a stratified shale which stands well in the workings and breaks in the mined areas. Medium soft fire clay bottom. The seam is generally flat but frequent rolls of from 10 to 20% grade. Cover 200 ft.

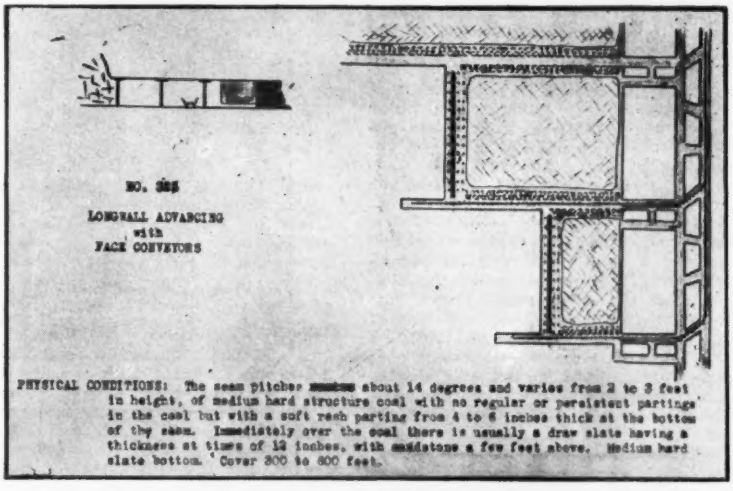
to employ mechanical loaders where mining conditions were favorable and to use conveyors under the more severe conditions where mechanical loading was not considered practicable, but it is by no means assured that this past tendency will apply to future developments. In fact we have considerable assurance that it will not.

It has been pointed out so many times that mechanized mining is a series of related or coordinated operations involving cutting, shooting, transportation, preparation, etc., that it is not necessary to dwell on this. It is, of course, of vital interest to know how these things are being done but we can not generalize on these subjects since they require a detailed study of each mechanical installation with its mining method and physical conditions to see the developments and modifications from previous hand mining practices in loading, shooting, transportation and preparation. In some cases these modifications have made it advisable to add additional equipment besides the loading machines or conveyors, but in many instances the companies have been able to operate successfully with the equipment already on hand and have not yet made changes although they do have them in mind. So while it may be recognized that larger mine cars, heavier track, haulage conveyors and mechanical preparation are desirable, these additions are generally not required to demonstrate the success of mechanical mining but are added later for increased efficiency and to further reduce mining costs after the success has been demonstrated.

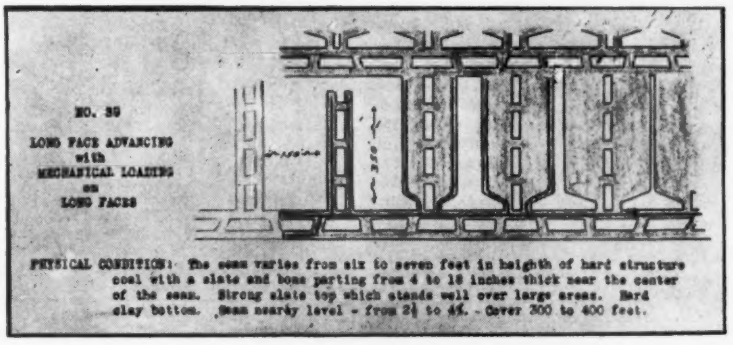
When we use the term "successful operations" just what is meant and what kind of success is being achieved? This question is raised here because there is a rather general impression in the coal industry that mechanical operators who say they are succeeding mean that on certain days or for certain short periods they do get satisfactory results. It is another impression that those operators who claim success are enthusiasts and because of their enthusiasm are "kidding themselves." These impressions originated a few years ago when they were, in many instances, undoubtedly true, but any one who now holds to these beliefs had better be sure that he is not "kidding himself." Disregarding figures and opinions and looking at some of the facts, it is hard to see why the many mechanical operations which have been and are still running on a full time basis would continue to do so if they were not sure of their results—certainly they would not go to the additional expense of purchasing more machines. A sufficient number are operating full time and have purchased additional equipment to warrant the belief that when they say that they are successful they mean just exactly that.




PHYSICAL CONDITIONS: The seam normally averages from 38" to 42" in heighth, of medium hard coal. The bottom, however, is very irregular with slate rolls cutting out the coal and reducing the heighth in some cases down to 18 inches. The seam lies fairly level but the bottom rolls give the effect of a continually changing grade. The top is a slate which stands well in the workings and breaks in the pillars. Cover from 300 to 800 ft



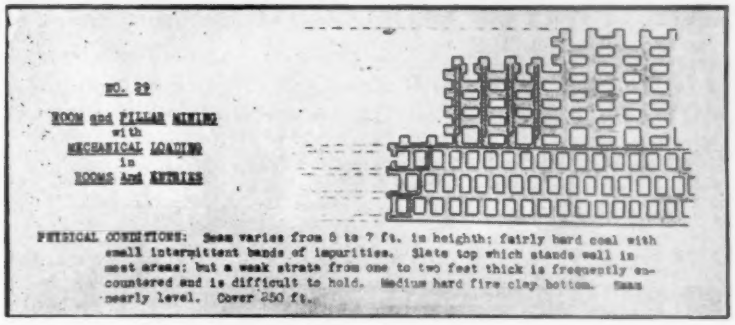

PHYSICAL CONDITIONS: The seam pitches [illegible] about 14 degrees and varies from 2 to 3 feet in height, of medium hard structure coal with no regular or persistent partings in the coal but with a soft rash parting from 4 to 6 inches thick at the bottom of the seam. Immediately over the coal there is usually a draw slate having a thickness at times of 12 inches, with sandstone a few feet above. Medium hard slate bottom. Cover 300 to 600 feet.

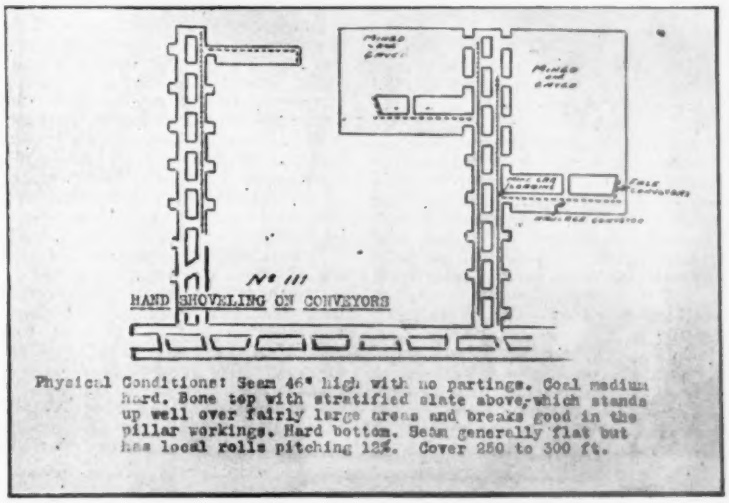



PHYSICAL CONDITIONS: The seam varies from six to seven feet in heighth of hard structure coal with a slate and bone parting from 4 to 18 inches thick near the center of the seam. Strong slate top which stands well over large areas. Hard clay bottom. Seam nearly level - from 2½ to 4%. - Cover 300 to 400 feet.

Detailed descriptions of these various operations, showing mining methods and conditions, telling how the machines and equipment are being used and what results are being attained, will be presented by papers to be read later in this meeting, and will also be covered by the reports of the mechanization investigation which will be published by The American Mining Congress. So it will not be necessary at this time to describe each of these 27 operations but some of each type are illustrated to give a general idea of the mining methods and the seams worked.

Now since it has been the attempt of this article so far to show that successful mechanization is not confined to any make or type of equipment, that it is being carried on successfully under a variety of physical conditions, that both established systems and new systems of mining are being used, that old equipment and new equipment are being employed, what then is the one requirement that is common to all these operations. There is but one thing—a management and a working organization that is efficient, progressive and favorable to the idea of mechanized mining and just as mechanical mining consists of a series of coordinated operations, its management consists of a series of coordinated positions and responsibilities extending from the foreman in charge up to the president of the company and if all these are not in harmony the result will be apparent at the working face underground. And in exercising its supervision the management is now being given an opportunity to regain two valuable assets that in recent years have been lost to the coal mining industry. One is to reestablish closer personal contact and relations with the men employed and the other is to encourage in the whole organization a feeling of pride in their work and their accomplishment. This


NO. 22
ROOM and PILLAR MINING
with
MECHANICAL LOADING
in
ROOMS And ENTRIES
PHYSICAL CONDITIONS: Seam varies from 6 to 7 ft. in heighth; fairly hard coal with small intermittent bands of impurities. Slate top which stands well in most areas; but a weak strata from one to two feet thick is frequently encountered and is difficult to hold. Medium hard fire clay bottom. Seam nearly level. Cover 250 ft.


Mines and Cars
Mines and Cars
Face Conveyors
Main Conveyors
N° 111
HAND SHOVELING ON CONVEYORS
Physical Conditions: Seam 46" high with no partings. Coal medium hard. Bone top with stratified slate above, which stands up well over fairly large areas and breaks good in the pillar workings. Hard bottom. Seam generally flat but has local rolls pitching 12%. Cover 250 to 300 ft.

feeling of pride now exists and justly so, for these men underground—mine superintendents, foremen, machine operators, motormen, timbermen, conveyor men, electricians and mechanics—have all played an important part in a real job of developing mechanized mining to where it is today.

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***DR. L. E. YOUNG.*** *Vice President of The Pittsburgh Coal Co., Pittsburgh, Pa.*, presided at the opening session of the discussions relating to Mechanical Loading. Dr. Young is chairman of the Mining and Loading Section, National Standardization Division, The American Mining Congress, and in conjunction with his committee has directed the activities of Mr. Glenn B. Southward, mechanization engineer, of that organization, in his nation-wide investigation into the adoption of mechanical loading by the coal mining industry. In opening the session Dr. Young said:

"It is a real satisfaction to see so many friends here who are interested in mechanical loading. I have endeavored to make a guess as to how much progress has been made in mechanical loading since we met last year. Unfortunately the statistics published by the United States Bureau of Mines for tonnage loaded in 1926 are not available. Undoubtedly you have all seen the mimeographed sheet which is published showing the tonnage by years and states, showing the number of installations and the number of machines.

"The American Mining Congress has been very active as you all know in promoting the work of mechanical loading and in furnishing information. I feel the American Mining Congress has played a large part in it and has been a big factor in the development that has occurred.

"For example, in 1923, according to statistics of the Bureau of Mines, we loaded slightly less than 2,000,000 tons mechanically. In 1924 there were 3,500,000 tons loaded and in 1925 there were about 6,250,000 tons loaded. The figures for 1926 are not available.

"I have talked with friends who are familiar with the situation in the several states represented in these statistics and have talked with various manufacturing companies who are furnishing the bulk of the machines that have gone into these plants in the form of loading machines, conveyors and scrapers, and other mechanical devices, and the best guess I can make is that in 1926 we loaded, mechanically, not less than 9,000,000 tons. Most of my friends think I am quite conservative. There has been an increase of at least 50 percent over the preceding year.

"In talking with some of the machinery companies, one of them says: 'We would have done a great deal better if it hadn't been for this or that, uncertainty as to wage rates, etc.' Another company says their output has increased 75 percent. Another company says that they know the machines they have put out have loaded at least 50 percent more coal per unit than in the previous year.

"When we consider all of these factors, somehow or other the 50 percent figure doesn't seem very far wrong. In checking with friends who know the situation in the several states, I feel that 9,000,000 tons is a very good figure for a guess for 1926. We shall be very much interested in hearing the official figures when they are available shortly.

"Moreover, our guess is that at the present time we have installed and have in operation in the various mines of the United States, machines that would load at least at the rate of 1,000,000 tons a month. Of course, a number of these machines are not operating now due to the fact that we have no wage contract. We shall be disappointed if the statistics for 1927 do not show that we have a capacity of at least 1,000,000 tons a month of mechanical loading.

"In this audience today there are some, possibly, who in the years gone by came to these meetings with the idea—'Mechanical loading—does it exist?' They sang it in a minor key. I think those men are here today with more of the spirit of the American on 'How to Get Bigger and Better Mechanical Loading in our Mines.' I think that spirit of optimism dominates this meeting here today.

"Before proceeding with the program, I think it is proper for The American Mining Congress that I should express a word of appreciation for the splendid cooperation which you have shown in the work of The American Mining Congress in its survey of mechanical loading. I think a word of tribute is due to our good friend, Colonel Roberts, who has been indefatigable in working on the program of providing funds for carrying on this program. I think we are indebted to the manufacturers who have made it possible to carry on this program of the study of mechanical loading."

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## CLEANING COAL AT PHELPS DODGE CORPORATION

(*Continued from page* 410)

of bone which is so close in specific gravity to that of the coal and the refuse. When using other coals from the same field we have been able to operate with two cells of the jigs and shut down the secondary tables and still obtain the same results.

On account of our proximity to the metal fields, our practice has been considerably influenced by that of the ore concentrators and this is responsible for the introduction of the concentrating table and Dorr thickener to coal washing.

The water consumption for the jigs and tables is 3,800 gallons per minute for 135 tons per hour of feed.

The power consumption, outside of the conveying system is 0.82 KW. H. for the washing machinery, 0.85 KW. H. for the water system and 0.75 KW. H. for the crushing of the washed coal, a total of 2.42 KW. H. per ton. The power for pumping is unnecessarily high, but is due to the fact that the power has been furnished from the waste heat from the coke ovens and the pumps were selected with the idea of a low maintenance cost rather than that of mechanical efficiency.

The operating cost outside of the conveying system, waste disposal and depreciation has averaged 17.5 cents per ton. This is higher than it should be as we have been operating in recent years at less than half plant capacity, single shift.

The operating results as given in this article are the averages of yearly results and not those of test runs and it might be remarked that there is a considerable difference between test rsults and those of regular operation.

# THE MECHANIZATION OF COAL MINING

## *Mechanical Loading A Major Factor In Mining Of Coal But Mechanization Of Other Operations And Improvement Of Production Technique Are Necessary To Secure Highest Efficiency*

*By* H. F. McCULLOUGH *

IN discussions of plans for the advancement of the coal mining industry the term mechanical loading is used with such frequency as to lead the uninitiated to believe that the millennium of the industry only awaits the coming of satisfactory mechanical loaders.

We, of course, understand that such is not the case, and that what we really seek is the development of its production technique along lines paralleling those which have already been developed by practically every other productive industry.

We seek first, more effective management: that is, coordination by means of specialized planning, scheduling and control; second, specialization of work; and third, the mechanization of operations.

Despite the faults of our terminology, we recognize our real problems and it is not here proposed to enter into a discussion of the general situation, but rather to deal briefly with the status of one phase of it, viz, the mechanization of operations.

In this we seek to increase the productivity of labor by providing machinery for every operation that can be facilitated thereby. However, here again, one would infer from our terminology that the problem of mechanization consisted only in securing satisfactory mechanical loading equipment.

Loading equipment provides for the mechanization of but one of the operations connected with the mining of coal. It is fully as necessary to mechanize the other operations. Loading is the major factor in the mining of coal but other factors are greater impediments to increased efficiency.

It is believed that we need a broader conception of the aims and possibilities of mechanization and as a step to that end some recent developments are worth describing.

We are all familiar with the progressive development and improvement of coal cutting machines and know that the various forms of arcwall, shearing, and combination arcwall and shearing machines make for greater cutting efficiency, and enable us to obtain not only larger coal but more coal per working place.

But these types of cutting machines have utility in other ways in facilitating the mechanization of coal mining operations. One of the first applications of the arcwall cutting machine was in connection with the making of the cut in the soft rock parting in the middle of the coal seam. After the removal of the cuttings there remained only clean coal to load out. The work of the hand loader was thereby facilitated. Now the same procedure makes it possible to apply mechanical loaders to the same character of coal seams without sacrifice of the quality of the product.

Recently a further development along this line has been undertaken. The arcwall cutting machine is now being fitted with collectors and conveyors so arranged as to receive the cuttings as they are brought out of the cut by the cutter bar and then to discharge it either directly into the gob or into mine cars, thereby eliminating the necessity for loading machines to handle parting rock.

It is believed that the same arrangement is applicable to the handling and disposal of the drawslate overlying some of our coal seams, and that the mechanization of operations in these seams will be facilitated thereby.

Refuse disposal can be and is being mechanized.

Power-driven hand drills are better than hand augers and tend to relieve the men loading coal of fatiguing and unproductive work, but they are inefficient and ineffective at best. Shallow and misplaced shot holes are limiting factors in the production of coal properly shot for loading out and with the greatest amount of lump. Misplaced shot holes are the

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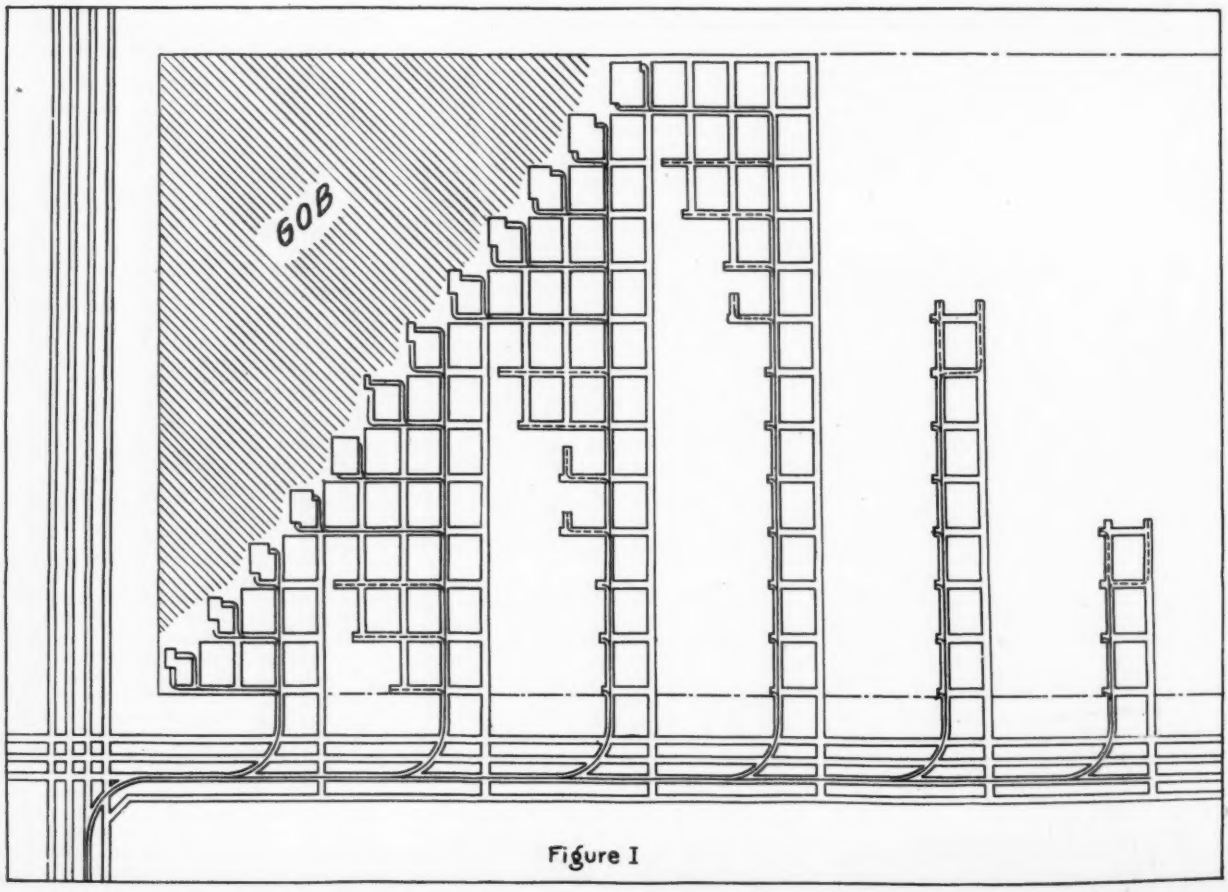



Figure I

cause of a large percentage of roof falls and the timbering costs that arise therefrom.

Recognition of these facts has led recently to the development of several types of self-propelled, power operated shot-hole drilling machines. These machines are arranged to drill holes by power in any desired place and manner at the coal face. They are placed on self-propelled trucks in the same manner as track mounted cutting machines.

By the use of such power drilling machines it is expected that the mechanization of hole drilling can be as completely effected as that of cutting now is.

The problem of roof control seems to have been born anew with the advent of mechanical loaders. It is obvious that the more coal there is in one place the less time will be lost in moving the loading machine from place to place.

On paper and to the uninitiated the obvious way out of the difficulty is to resort to some form of long-face work.

In the generally thick and comparatively shallow coal seams in this country the various forms of bord and pillar, or room and pillar, systems of mining, when properly planned and worked, permit the recovery of a very high percentage of the seam with only small expenditures for timbering.

In principle, long-face methods of working offer greater opportunity for full realization of the possibilities of mechanical loading than do board and pillar methods. Experiment with and development of such methods of working should be carried on by those prepared to do so. But, in general, long-face methods of working involve us in roof control expenses which may easily exceed all the savings that it would be possible to make through recourse to mechanical loading.

We embark upon long-face experiments to create more favorable conditions for mechanical loaders. But have we really gone as far as possible in so arranging and modifying our present systems of mining as to justify us in stating that we have shaped them so that they can not be better adapted to mechanical loading. We really have done very little toward this end.

Thin coal presents a different problem, but in our seams of ordinary thickness why not first or concurrently develop the full possibilities of our present bord and pillar systems of mining?

Figure 1 represents a general method of approach to this problem. It is foundationed upon our present practices, is applicable to a wide range of mining conditions, does not sacrifice safety or welfare standards, permits the installation of as an elaborate or as simple a track arrangement and transportation system as may be found necessary to realize the full possibilities of mechanical loaders, and finally, does not tie the operation down to one system or method of working, but permits development and change of plans and methods as the work progresses, as conditions encountered change, and as new and better equipment, almost irrespective of type, becomes available.

Transportation for mechanical loaders is purely a matter of track—what kind and where. Mechanical loaders have emphasized two facts about real mine track—viz, that very few mines have any, and that what they do have is inadequate for the purpose. Keeping loading machines supplied with mine cars at the rate of a car every several minutes can not be done with the ordinary run of track and haulage facilities.

Figure 2 illustrates an effective track arrangement for use with mechanical loaders when a plan of development such as is shown by Figure 1 is used.

There is nothing new to be said about loading machines. Given the conditions possible through a properly planned and executed system of mining, and adequate transportation facilities, success is largely dependent upon effective management, which means coordination by means of specialized planning, scheduling and control.

The loading machines are available. We must learn to supplement them and how to use them effectively.

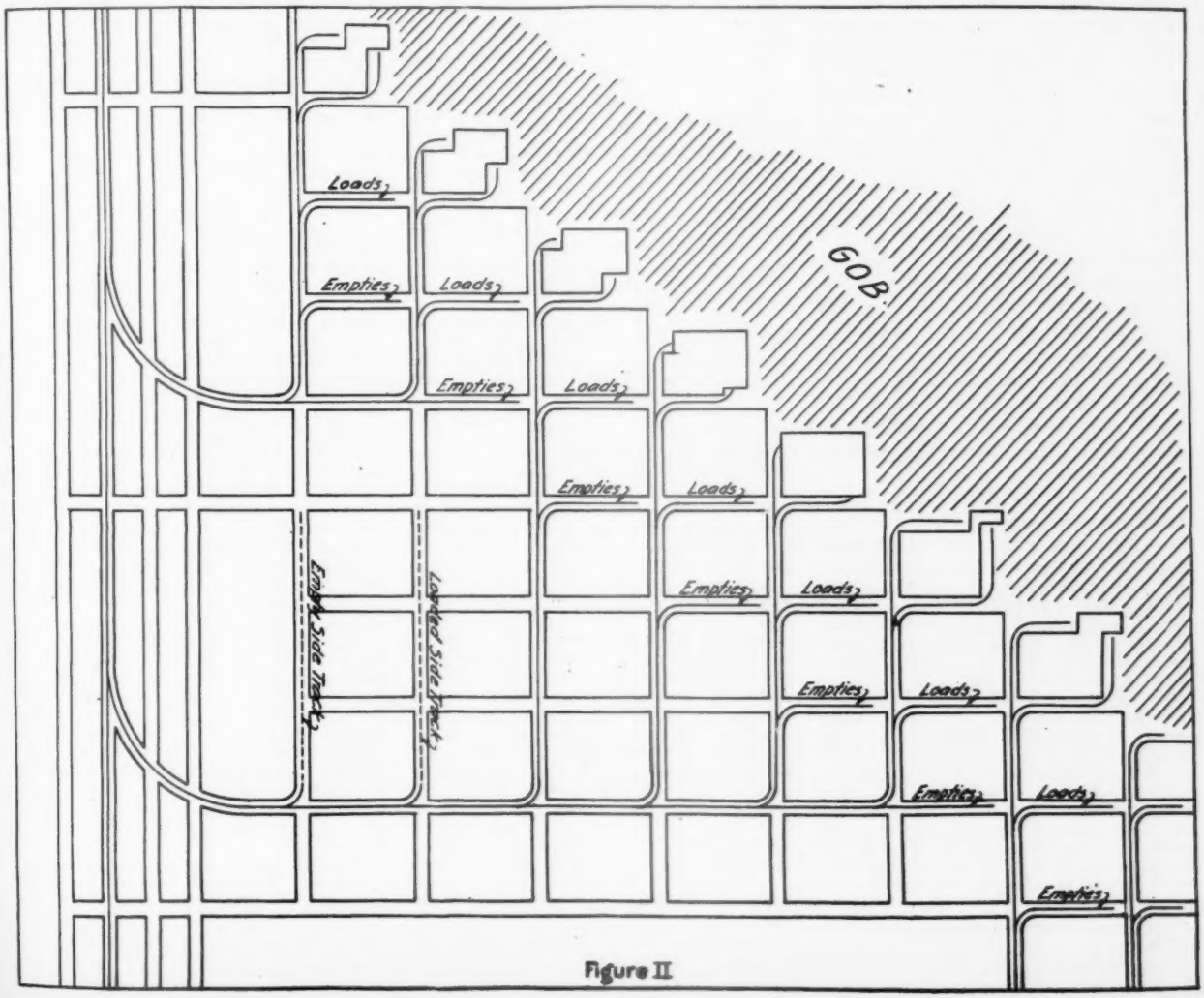



Figure II

# DEVELOPMENTS IN CUTTING, SHEARING AND SNUBBING WITH MECHANICAL LOADING

*"Development" Includes Both That Of Personnel And Of Mechanism—Long Cutter Bars Yielding Loose Coal Advantageous With Mechanical Loading—Shearing Increases Lump Coal And Decreases Powder Consumption—Snubbing Indicated In Laminated Coal*

By ROBERT J. SMITH*

TO BEGIN with, let me make definition of one of the terms. "Development" may be of two kinds if reference is had to mechanical loading in mines, which have only day work instead of piece work, or instead of mixed day work and tonnage. One development is of the men or personnel of the mine; the other is of the mechanism. The usual background of a mechanical mine is the way of thinking and the training that goes with tonnage or piece work. An undercutting machine is any old cutter; a breast machine, or a worn out, or a one-half efficient shortwall machine, with a short cutter bar. When cutting is paid for by the ton why should the management worry about the sort of machine used? When a mechanical mine is on a day wage only, why should the employe worry about the sort of cutter used? The first development then is to get the mine management thinking in the terms of efficiency; to do away with breast machines, and cutter bars where longer cutter bars can be used in a particular vein of coal. Where the vein is suited to it, a cutter bar 8 ft. 4 in., 8 ft. 6 in. or 9 ft. can be used, with a 50 H.P. motor. As far as I am aware, mechanical loading found the cutting machine already developed and awaiting, that is, the machine with 50 H.P. and the long cutter bar.

One thing is to be added here; the long cutter bar makes for a bigger pile of coal when the coal is shot down. That means more work for the loading machine before a move to another working place is necessary.

The use of the shearing machine, which makes a vertical kerf, is a development that has come with the loading machine. It serves a two-fold purpose, the making of loose coal and the giving of more blocky and firmer coal with less fines. Incidently, it cuts down the quantity of powder used in blasting the coal, about one-half. This is a saving because with mechanical loading the company pays for the powder. The diminished quantity of powder, especially when speedy permissible powder is used, greatly reduces the damage to roof, whether the roof be slate, or if coal be left up in entries. Such shearing greatly aids roof control. The cutter bar and chain used in shearing are the same as used in undercutting, the kerf being the same, about 6 in. in width. The kerf gives opportunity for the shot to expand, the same kerf being closed by the jumping over of the coal when shot.

My experience with shearing is limited to the use of an independent or separate shearing machine. We have a Universal Cutter of the earlier type but have used it only for shearing. This machine sumps into the coal by moving forward by tractive force on a track. We have settled down to the use of this machine for almost wholly center shearing. As we aim to keep our entries 11 ft. wide, a center shear is very satisfactory and is quickly made. In rooms of 21-ft. width, cut by one shear, the kerf should be about 7 ft. from the rib. On the short side one shot is used, on the other side two shots and in rooms of 26-ft. width three shots are placed.

We use another shearing machine designed and built by a shop in Terre Haute. A standard shortwall machine is placed on edge on a truck, the cutter bar lengthened to 9 ft. and set to cut 18 in. outside the rail. The machine is clamped in a frame formed of four heavy steel rails. Before sumping begins, the frame is supported and leveled by screw jack attached to the frame. The sumping is done by means of the ordinary feed chain. The frame is pivoted upon the truck and can be turned so as to shear at an angle from the truck, by which means room necks can be sheared. Feed by means of traction through the wheels can not be used on a curved track, whereas the chain feed machine can be used to cut room necks.

The locally built shearing machine fits in well with the shovel loader as the track for this loader is placed next to the left rib and the cutter bar is placed 18 in. outside the right hand rail, making the kerf about 7 or 8 ft. from the left rib.

Either the Universal or the locally built shearer will put in a shearing cut in about 15 to 20 minutes. This does not take into account the movement of the machine from one place to another.

We have now brought this subject to the most serious drawback in connection with shearing—that is the use of the mine tracks, so as to keep out of the way of traffic. As at least one motor serves one loading machine, and as track room is taken up by the empties and the loads and the shuttling of the gathering and bottom locomotives, it is constantly a proposition to get the shearing machines to the faces to be sheared. Our experience is that only about one-half time is used in cutting and one-half lost in waiting to get by and out of the way of traffic. This means very poor efficiency. We have never used a shearing machine placed upon a caterpillar, although such machines are on the market. The advantage of these machines is that they can pass from room to room through the breakthroughs, or crosscuts. They can shear anywhere in front of the cutter bar and make two shears in a 26-ft. room. They work in well with the shovel loader, following it through the breakthroughs and making loose coal for the shovel by two shears in a room. The objections to the shearing machine on a caterpillar is that it is necessarily long, about 21 ft. over all with a 9-ft. cutter bar. Where the roof is poor and much timbering required, the caterpillar shearer is out of the question. Another objection to a shearer on a caterpillar is that it advances when sumping by tractive power. If cuttings from the undercutting are lying or piled near the face, the cutter bar will pinch, due to the uneven floor under the caterpillar. The pinching of the cutter bar will often stop the driving motor.

We are now trying to get the locally built shearing machine on a caterpillar, hoping for two advantages, the length over all will be only about 14 ft. and the chain feed will make a perfect kerf without pinching the cutter bar.

In some seams of coal snubbing without shearing has proved most practical. This is the case where the coal is laminated, or has partings near the bottom. If there is a dirt band, 12 to 16 in. from the bottom, snubbing by placing small shots just above the dirt band may be very successful. Where the coal thus snubbed is shoveled back, the dirt band is separated from the coal and gobbed, then the main body of coal is shot down.

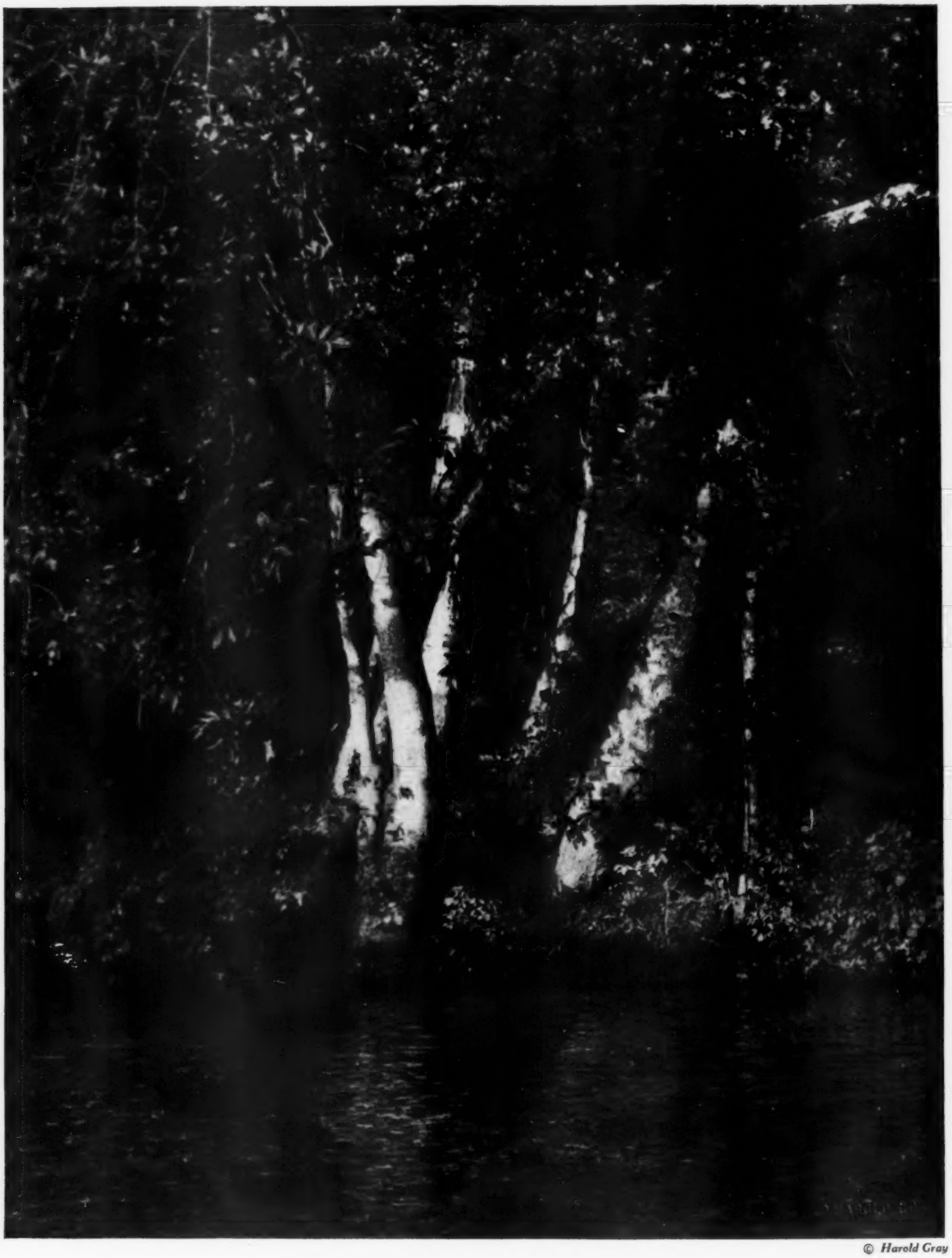
In our seam of coal the following practice gives the best results, taking into consideration that our coal is largely domestic and the mining mechanical. First, the seam is undercut, then sheared, then snubbed. The men who snub the coal clean out the bug dust from under the shot, then knock down the coal up to a parting which is 12 to 14 in. from the bottom, remove the knocked down coal and pile it back so the shovel can get it.

As the success of mechanical loading depends up to date on loose coal, it pays us best to undercut, shear and snub. If a shearing machine is broken down, and only snubbing is done with the undercutting, the tonnage handled by the loading machine falls down about 10 percent unless the grade of the coal is greatly depreciated into fines by heavy shooting.

As a separate shearing machine is so much in the way of traffic, and requires extra men whose time is lost by changing from place to place, the present demand is for a machine that will both undercut and shear successfully, and in addition carry a drilling outfit. Especially would such a machine be of advantage in entry driving and narrow work, leaving the rooms and wide places to be taken care of by a shearer on a caterpillar.

One fact stands out of the highest importance. Mechanical loaders, as far as developed to date, must have loose coal. Working off tight shots confronts every effort and must be done away with.

* President, Princeton Mining Co., Terre Haute, Ind.



© Harold Gray

*Along The Potomac Above Washington*

*"Time has fallen asleep in the afternoon sunshine"*

# TO WHAT EXTENT DOES ROOF CONTROL AFFECT MECHANICAL LOADING

*Operation In Thick Vein Freeport Coal With Tender Roof—Control Of Roof Pressure Affects 80 Percent Of Recovery—Safety Also Features Largely—Continuous Operation Yields 18 Tons Per Man Per Day*

By Wm. G. Fletcher*

THE subject assigned me, "To what extent does roof control affect mechanical loading," is quite a large contract; like the farmer when he saw his first giraffe, "There ain't no such animal," as Roof Control.

I might answer, in a few words, that so far as our experience goes, roof control affected our operations approximately 80 percent.

We are mining what is known as the Thick Vein Freeport Seam in Allegheny County, located in the western part of the State of Pennsylvania, averaging about 8 ft. thick, a very tender roof, and with a cover of 200 to 600 ft., there is from 8 to 12 in. of shale rock that resembles the draw slate in the Pittsburgh Seam. Above that we have 18 ft. of a gray shale and 12 ft. of red shale with a series of laminations of various kinds on to the surface, making a total of approximately 500 ft. of cover at a point where the long face work was done.

Our faces were 130 ft. long; we used face conveyors, discharging on to lateral or main conveyors to a loading point on the entry. The coal was undercut by longwall mining machines and the roof was supported by cribs built of 6 in. by 6 in. by 30 in. and later 6 in. by 6 in. by 36 in. hard wood blocks, set about 2 ft. apart on a few inches of slack coal for making removal easier.

We did not mind the roof breaking along the face so long as it did not shatter or splinter between the cribs and face. Often we had a crack as much as 6 in. at the face of the coal which, when properly wedged, gave no trouble, but when it splintered and broke we had to fore-pole and lag, and at that were often forced to let it come down and load it out, which meant extra expense and delay.

After starting the No. 2 Face, the roof would break across the corner next to the chain pillar between the two faces, which up to this time had been mined by the regular hand loading method. To overcome this trouble we tried leaving in the chain pillar and throwing the pressure area on the center. This gave us the desired effect and demonstrated the fact that we could, at least, shift the pressure area by sacrificing our chain pillar of about 36 ft. of coal, or approximately 55 tons lost for every cut on the long face. Naturally, the practical miner dislikes the idea of losing a pound of coal if it can be economically recovered, so we began devising means of recovering the chain pillar and still control the pressure area. We extended our face conveyor across the entry, lengthened our crib line and carried a line of five cribs down the chain pillar entry, leaving a small skip or rib of coal to protect our men from sliding rock, for three reasons:

1. To afford a second escape way for our men working on the face.

2. To maintain proper ventilation.

3. To do with the extra line of cribs what we did by leaving in the chain pillar, i. e., keeping the pressure in the center rather than across the corner.

The first two ideas worked fine, the men felt safer knowing there were two ways of escape in case of roof trouble instead of one as heretofore, and it also afforded us an opportunity to work from two open ends when conditions warranted. The ventilation was much better, but we began having roof trouble between the cribs and the face.

By this time we had started No. 3 Face and, from the third cut, had as much trouble as on No. 2, which was 200 feet in advance. This did not occur on No. 1, which was 275 ft. in advance of No. 2, until some time later, then it was as bad as No. 2 or No. 3 despite the fact that we had solid coal on one side and a very large chain pillar on the other. We then decided to go back to the old method of removing the chain pillar by hand, shortened our crib lines accordingly, but maintained two to three cribs down the chain pillar for an exit and ventilation. A short time after this change the roof conditions became very bad, but we did not have much trouble the last two weeks the faces operated.

The change in our method of mining the chain pillar or the fact that we were getting to the edge of a very steep hill on the surface may have had a tendency to throw the weight on the faces. After cessation of mining April 1, 1927, we had a surface break, which might have saved us a lot of worry and expense if it had occurred a few weeks sooner.

### General Information

The crew consisted of two lead-off men and two follow-up men on the face, a man on the entry who attended to the loading of the coal, spotting the empty cars with a small electric hoist, and a face leader who saw that the coal was properly prepared and looked after the work in general.

After the coal was loaded out, a cutting and shearing crew of three men came on to cut, sprag, load out the slack, drill the holes, which were 6 to 7 ft. apart, and move up the face conveyor with chain post pullers, then completed their shift by taking down and building cribs. This shift was followed by two men known as cribbers, who completed changing the cribs and had the place ready to go by 7 o'clock the next morning. Each face produced 180 to 210 tons coal per cut. This gave us an average of approximately 18 tons per man employed for the complete cycle of 24 hours.

As much bony as possible was thrown back in the gob, the balance was loaded out after the day's cut of coal was finished. The timber recovery, of course, depended altogether on the action of the roof. If it settled down all along the face, it was often necessary to shoot out the crib blocks, which destroyed quite a number of them and reduced our percentage of recovery. In fair roof conditions we saved approximately 65 percent and in our worst roof conditions it would run as low as 10 percent, which meant a very high timber cost.

Our cost was divided approximately as follows:

| | Percent |
|---|---|
| Timber | 25 |
| Explosives | 8 |
| Labor | 54 |
| Power | 3 |
| Maintenance | 6 |
| Repairs | 4 |
| | 100 |

We were fortunate in not having a fatal accident and there was very little time lost with minor accidents, due to close supervision on the part of our foremen and also because our men realized the danger under which they were working, as there was no use to disguise the fact that it was very hazardous with our roof conditions.

## UNJUST TAXES RAISE ANTHRACITE COST

High anthracite prices hurting the industry are laid to the door of "political taxation" by heads of the anthracite coal industry in a statement issued at Pottsville, which shows how local political bosses in the mining cities and towns have sought popularity by increasing taxation on coal interests to a point where other taxpayers contributed only a minor fraction of the cost of county and town upkeep.

"The people of the anthracite region are largely to blame themselves that the demand for anthracite has been curtailed this year," says the statement, which goes on to say that taxes on a ton of anthracite being mined amount to more than 70 cents, which makes it difficult to meet competition because of the overhead expense which bituminous does not encounter.

The operators add in the statement that for every person employed they pay an average of $120 in taxes every year. The companies are subjected to state, county and borough taxes, while in recent years the school tax levies have increased 100 percent. In some instances practically the entire cost of the school system is borne by the anthracite industry. "The people of the anthracite region must lessen this burden or the sun of prosperity will cease to shine on the coal fields and the miners will work only half time because high prices necessitated by high taxation are knocking out the demand for anthracite."

* General Superintendent, Inland Collieries Company, Indianola, Pa.

# "IS MECHANICAL MINING DEPENDENT UPON ROOF CONTROL"

*Roof Control Is Fundamental—Problem Always An Individual One — Shallow, Average And Deep Cover Defined — Primary Roof Conditions More Significant Than Main Roof — Hand Cleaning Essential Where Brittle Slate Is Encountered*

*By* THOMAS W. DAWSON*

THE question, "Is Mechanical Mining Dependent Upon Roof Control," is probably the predominating one that faces the coal mine operator, mining engineer, or other mine official who is interested in or has installed coal loading and conveying machinery underground.

Roof control is fundamental to the whole operation. Theories and conclusions have been advanced by our geologists and students of this subject and considerable data have been and are being collected by the "pioneering" coal mining companies through their progressive officials who understand, at least in part, and accept this natural challenge.

The deeper we penetrate this problem, with its innumerable peculiarities of roof action, the more we are led to believe that the solution of this phase of mining must be local although there are a number of generalities or governing factors which can be referred to that have developed from experiments made on a practical scale under a wide range of conditions.

Numerous examples illustrate the advisability and value of making local experiments to determine the characteristics of the roof and what dependence must be placed in the control of this roof. Driving rooms at various widths and centers, with cut-over or open-end rib extraction employing variable systems of timbering have indicated the feasibility of a change to the modified long face method, the V-System, or a modification of the present room-and-pillar or block system of coal extraction to obtain more economical as well as a safer winning of the coal.

It will be necessary to subdivide or limit our generalities or governing factors. Depth of cover might be the first. Shallow cover, 10 to 50 ft.; average cover, 50 to 500 ft.; deep cover, 500 to 1,000 ft., and excessive cover, 1,000 or more ft. A mining method possible in a shallow mine is oftentimes prohibitive under a deep cover, numerous examples of which you can call to mind.

Again, in analyzing our dependence upon roof control, we must consider the type of roof and also distinguish between the "primary" or immediate roof overlying the coal seam, and the "main roof" or overlying strata extending to the surface, since the action and maintenance of one is dissimilar to the other, although the control of the primary roof is largely dependent on the action of the main roof.

As a rule, maintenance of the primary roof has been the chief obstacle to mechanical loading under the room-and-pillar system of mining and control of both the primary and main roof has obstructed development of mechanical mining in the shortwall or block system of mining.

Surface subsidence over shallow mines must be expected and the full pressure of the overburden will be exerted onto the coal or other supports directly below. The roof is usually weak and this problem evolves itself into a matter of proper spacing of posts to facilitate movements of the loading equipment. It was noted at one mine which was working a 5-ft. seam under shallow cover of less than 60 ft. that an attempt to protect the roof by overcutting the room face leaving up a few inches of coal was annulled by springing of the roof due to the tendency of the 10 inches of drawslate to part from the overlying wild or rider coal and shales with insufficient support so that the loading machine, although it had room to operate, was too heavily handicapped by the slate that came down to make any kind of a showing. Less than 60 percent of the coal was recovered.

A majority of the coal mines fall into the second class, 50 to 500 ft. of cover, and a very large percent of our coal is extracted by the room-and-pillar method. The shortwall or block system of mining has been confined practically to Fayette, Westmoreland, and Greene Counties of Western Pennsylvania.

Surface subsidence is too costly in quite a few districts of Illinois and other states to permit divergence from the room-and-pillar method without continuing to abandon 40 to 50 percent of the coal in the thicker seams in order to carry the overburden. In these cases dependence upon control of the primary roof is very evident. Loading machines have sufficient capacity to compete successfully with hand-loading under favorable conditions, natural or man-created, but when slate is encountered these machines do not discriminate. Since it is necessary to loosen the coal over the full depth of the cut the roof oftentimes suffers from overshooting. This latter condition must be avoided and yet poor coal preparation may result which would so slow up the loading operation as to eliminate any savings due to increased production per shift. Shearing with overcutting or undercutting is accomplishing commendable results including better control of the primary roof.

Successful application of mechanical mining and loading to long face work depends principally on the maintenance of sufficient open space along these faces to accommodate movements of the loading equipment at these points. As a general rule, the less the width of the working space between the retreating face and the line of supports the greater is the possibility of success.

In the Pittsburgh and southern Connellsville districts of Western Pennsylvania the mines operating in the thicker seams, 5½ to 8 ft., under an average cover, that have experimented with long face methods of coal extraction have met with discouraging results with respect to mechanical loading versus hand loading, although several experiments now in the course of development portend a better comparison.

In the southern Connellsville region where we have experimented with faces varying from 30 to 200 feet in length, and with blocks of coal varying from 2,500 to 30,000 square ft. in area, several governing factors have forced themselves upon us as has been the experience of those who have followed similar lines of research, namely:

The faster the rate of retreat the less roof trouble develops.

Faces of moderate length, 30 to 100 feet, can be most successfully worked.

The angle of the gob line to the face or butt varies the intensity of the pressure on the coal face.

A minimum number of development entries or rooms gives best protection to working faces or places along the gob line and reduces troubles usually encountered in crossing such workings on the retreat.

Minimum area of working space between breakline supports and retreating face yields best maintenance of the primary roof.

Stepping the faces along an approximately 45 degree gob line has given best protection to the working faces.

We have kept a number of objectives in mind:

Safety of the miner and dayman.

Maximum recovery of the coal.

Satisfactory sectional labor and material costs.

In making comparisons the characteristics of the roof, such as strength, flexibility, slacking properties, etc., must be taken into consideration. For instance, the success obtained in a 40 to 50 in. seam with an excellent roof, no drawslate, where rooms are driven 30 to 40 ft. wide and the pillars 15 to 40 ft. wide are extracted on open-face rib work with the roof held by posts over areas of 60 by 70 ft. or more should not be used as a basis of comparison with a mine operating in a 6 to 8-ft. seam with heavy drawslate and weak shale above, in so far as dependence on the roof control is concerned.

An instance occurs to me where mechanical mining, including loading and conveying, is employed with the V-system of coal extraction in a 40 to 50-in. seam, with good roof, under a 300-ft. cover and where dependence upon roof control is ably illustrated. Cribs are used to protect the apex of the converging faces and timbering to maintain the necessary working space along the 75 to 90 ft. of face. The timbers are abandoned but the cribs recovered.

The face has been lost several times due in part to insufficient timbering at critical times of roof movement, but with the open area maintained by the cribs and surrounding coal these faces are recovered in a relatively short time. Previous to the installation of these V-faces tests were made to determine the strength of the roof and its other characteristics by driving up various widths of rooms and bringing the ribs back open-ended.

Where the coal is worked in solid blocks or sufficient pillar is left between rooms there is little crushing of the coal. Under the block system of mining dependence on control of both the primary and main roof is paramount. There is

* Chief Engineer, H. C. Frick Coke Co., Scottdale, Pa.

always a protected area enclosed on two sides by blocks of coal so that the roof-break describes a curve cutting the coal buttresses some distance back from the corners projecting into the gob and bowing in toward the protected corner. The main roof sets down almost solidly against the upper or gobward sections of these faces relieving the coal of considerable weight.

Until sufficient coal has been mined out from under an overburden of 200 ft. or more, the side thrust due to the pressure of the overlying strata will sustain the weight of the latter. Following a major fall almost the full weight of this strata is thrown upon the coal adjacent to the mined-out area. The results from this condition will indicate whether this mining method can continue or the face be abandoned. It is possible to return to this point and repeat the operation after the caving is completed, but a modification of such a system would be the more promising option.

There are two types of roof action, "bending roof action," where a flexible roof under the weight of its overburden sags until it reaches the floor of the mined-out area, and "caving roof action," where an unflexible roof under similar weight breaks and caves into the gob leaving ledges protruding out from over the face and fracturing the primary roof adjoining the face.

Long wall work, generally, is limited economically to the former roof action. The breakline is kept back from the working face by pack walls and cribs, so that the necessary space along the active face kept be kept open. Where waste material from the roof or floor is insufficient for the erection of these pack-walls recourse to material from outside the mine will be too costly, so that long-wall work will for the most part continue to be confined to the thinner seams.

Returning to the long-face operation as adapted to mechanical loading, we must note the difference between the weight supported by the face timbering and that supported by the coal. The former supports the primary or immediate roof only and is rarely strong enough to withstand the enormous pressure of the settling or caving strata which is borne by the solid coal adjoining the gob.

Instances can be cited where jacks of such strength are employed. Timber and jack handling is a very costly part of the operation and in some cases has been prohibitive. In one case the heavy jacks were recovered by a small hoist and this part of the cycle with the resetting of the jacks required about one-third of the full cycle time, using a 100-ft. face in a 6-ft. seam with a 250-ft. overburden.

The retreat must be rapid enough or the working area sufficiently protected to avoid caving or settling of the main roof where such roof action will fracture, weaken and drop the primary roof over the active area. The main roof or strata must be caved before it can impose its weight on this primary roof or crush the coal along the face.

The crushing pressure of the subsiding roof is sometimes depended upon and utilized in the deeper mines to break down the undermined coal. This would be most successful where the rate of retreat is in conformity with the rate of roof bend or caving. This operation would be impossible where the roof fractures and blocks the available working space.

As an example of the great variation in the action of the roof strata, the pocketty nature of the 1,000 to 2,000 ft. of overburden in some parts of Kentucky where there is no definite plane of fracture can be cited as against the regular planes of fracture common to many localities where the caving overburden varies from 200 to 700 ft.

Mechanical loaders cannot clean slate. Unless the slate can be kept up by methods previously described hand picking at the face or mechanical and hand picking outside must be relied on. Let me repeat, the roof pressure along an active gob line can be varied by the shape and proportion of the faces and steps with the object of obtaining uniform pressure and settling along the full length, that rapidity of coal extraction is the chief panacea for the evils of roof trouble, and that maintenance of the minimum amount of roof span between the active face and lines of support should be our objective in the choice of loading equipment to be employed along the face.

As in other lines of endeavor the open-door policy of the coal operators to prospective users of similar methods and equipment is noteworthy and commendable. This policy with the trials of unproven equipment in going mines for the manufacturer has beneficial possibilities to all parties and will be a means of accelerating the progress of mechanical mining and loading underground.

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***DR. J. J. RUTLEDGE**, Chief Engineer, Maryland State Bureau of Mines, Baltimore, Md.*, led the discussion following the papers presented on roof control, saying as follows:

"I had the pleasure of visiting the mine described by Mr. Fletcher. I think that his company deserves a lot of credit for what they have done. I have never seen coal as thick as the seam that they worked. It averaged about 9 ft. thick with very poor roof conditions.

"Another item I think deserves considerable mention, which Mr. Fletcher, probably on account of the limited time at his disposal, did not refer to. That is the character of cribs used there. I called them a figure 4 type. You can knock the crib out with the removal of a wedge. One member of the crib is made up of 6 by 6 pieces, I should say about 3 or 4 ft. long; one member is made up of triangular pieces and this built-up member fits in a notch in the members below and is wedged in there. By means of a sharp blow the wedge can be knocked out and the crib dislodged.

"At the time we visited the mine they were carrying only one line of cribs and were getting away with it. These cribs were being removed. Almost anybody can put cribs in and leave them in, but it takes a man to take the cribs out.

"At our last meeting we had a very interesting discussion and we brought out the difference between the old advancing method using packwalls where the principle of the weight thrown on the face of the coal was made to work the coal, and the new method. In other words, we contrasted that with the present method where the weight is thrown back on the gob in one way or another and the face is relieved.

"Mr. Fletcher referred to the cutting of the roof along the face. That is almost the universal experience of those who have adopted some method of panel-longwall mining, especially panel-longwall advancing. The great reason is that the weight has been thrown on the face and has not been thrown back on the gob.

"A difficulty encountered by all is the competitive cost of timber. If cribs are used and you leave them in you lose that much timber. If you take them out you run some risks. I believe it is perfectly feasible to break the roof 20 ft. from the face and take the timber, jack, or other support out and leave the weight behind you and go on reducing your timber costs.

"One of the great troubles with the new systems has been the extremely high cost of the timber. I think we ought to include in this vote of thanks the men who developed the jacks because they are certainly on the right track, especially as regards the reduction of cost in timber. That is the next thing we will have to take up.

"I believe that in a very short time you will see a more uniform system of mining—not altogether uniform because conditions vary too much in different regions, but you are going to see roof control so handled that in many cases it will be perfectly feasible to use mechanical loading."

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***MR. L. F. GERDETZ**, Georges Creek Coal Mining Co., Pittsburgh, Pa.*, in discussing these papers said:

"Mechanical loading, as far as room and pillar mining is concerned, will in my opinion be successful to the extent that cutting machines are successful, but no more. As far as longwall mining is concerned—that is mining for 100 percent recovery—it will be 100 percent successful.

"What mechanical equipment will be used in longwall mining remains to be proven. Equipment has not been developed to a state where you could possibly say that such and such equipment is positively the only one that will do the trick.

"Roof control is the most important factor to successful mechanical mining on a longwall face. However, it is not as important as very many engineers and operators want to make it. There are other factors in mining that are far more important than the control of roof. I think the control of roof will come of itself. People engaged in that sort of mining will gradually acquire a knowledge of that work and will not think very much about that afterwards.

"My friend, Dr. Rutledge a little while ago mentioned a point about controlling the roof in a manner where you can break it 20 ft. back of the face, or 25 ft. back of the face. I don't agree with that point at all. In all my longwall mining experience from a depth of 3,500 ft. and 1,500 ft., I have never seen anything like that. It is hard to believe that anyone who knows geology and appreciates the weight of a super-imposed strata would believe that you could break a roof anywhere else but on the face. I can not imagine an artificial support made that will enable anyone to break the roof back of the face, not 20 nor even 10 ft. or 5 ft. The initial fractures of the roof occur only on the face and no other place. I say the initial fractures. Those fractures may be minute fractures, hardly visible but they will occur always on the face and nowhere else. (*Continued on page* 462)

# HOW HAS PREPARATION INCREASED USE OF LOADERS IN COAL SEAMS WITH DIRT BANDS

***Rock Parting And Bottom Coal Shot And Loaded First—Loose Lumpy Coal Assured—Machine Repairs Reduced—Shearing Sometimes Recommended—Rib And Center Shearing Discussed—Combination Cutting, Shearing And Drilling Machines Advocated***

*By* DR. E. E. FYKE*

THE Illinois No. 6 vein, which is mined over the greater part of Southern Illinois, is known as the "blue band" coal because of the presence of a dirty band from 2 to 6 in. in thickness. Its distance from the bottom varies with the thickness of the coal seam. In the Centralia district there is from 10 to 18 in. of coal below the blue band. This formation is of rocky hardness and is the greatest impurity found in this coal seam.

Mechanical loading was started at my operation in April, 1925, through the use of the Jeffrey pit car loader. It was found that approximately 25 percent of the time of the shovelers was spent pulling coal from the face. In addition, a large percentage of gainful labor was lost in the work of searching for and removing the particles of blue band mixed with the coal. To overcome these deficiencies the method to be described was adopted.

This coal has an average height of 6½ ft. After undercutting, using a 7½-ft. cutter bar, five drill holes are placed in the coal immediately above the blue band across a 30-ft face. These holes are charged with two sticks of permissible powder in each of the rib holes and one stick in each of the inside holes, and are fixed at the close of the day shift. Men working at night remove the coal and blue band brought down by these shots, gobbing the impurities. Coincident with the disposal underground of the major impurity in the coal, there has been made a space from 14 to 20 in. in height extending from the face to the back of the cut. The main body of coal is shot at the end of the night shift by four holes placed near the roof, the rib holes containing three and the center holes two sticks of powder. Due to the thorough snubbing the fall of coal is all that could be desired for loading with a machine which takes its coal from the bottom. No part of the time of this machine or of the men is taken up in mining coal. The loose coal of itself falls onto the loading head, making it possible for the actual work of loading coal to be accomplished at an average rate of 50 seconds for a car holding 4,500 pounds.

Our experience has taught that preparation of the coal face increases the use of loading machines by increasing the tonnage loaded. The machine can load coal at all times, without the delays incident to mining and dragging down the body of coal. A double purpose is served when conditions are such that a dirty band near the bottom can be handled separately from the body of coal. Leaving the impurity in the gob relieves the strain on the machinery and the picking-table men. The excellent snubbing obtained through this method insures a fall of loose, lumpy coal, which means efficient loading time and a minimum of loading machine repairs.

* President Marion County Coal Mining Co., Centralia, Ill.

***MR. C. B. OFFICER,*** *The Sullivan Machinery Co., Chicago, Ill.:*

"It is my impression on mechanical loading, operating on room and pillar system that you should either snub your coal or have it sheared. I consider snubbing useful and in certain veins of coal, like that mentioned by Dr. Fyke, where his conditions are such that he is bringing down a large area of coal and separating out his blue band it is useful. In other seams you can accomplish the same results at less operating expense by shearing. Your shearing cut gives you, of course, more area for your coal to expand in.

"On any loading machines, as far as I have been able to follow them, I find that with places sheared the loading machines produce very much more coal. They can load the coal a lot easier. They also load the coal with less repairs. They do not have as hard work to do.

"There is another advantage of shearing. Shearing was put in so as to prepare the coal for the mechanical loaders. When you shear coal, you can generally undercut it deeper. In a mine where you have been undercutting 6 ft. and possibly getting 40 tons in your room by shearing you can increase the depth of your undercut to 9 ft. and increase your tonnage in that room about 50 percent. The more tonnage you get into the rooms, the more tonnage you will load with the mechanical equipment. You get more tonnage in front of your machine and you have fewer moves to make with your mechanical equipment.

"There has been one objection to shearing in the past, which is that it means an added piece of equipment in the mine. You have an undercutting machine, a shearing machine, a drilling crew, and a loading crew. Frequently the shearing machine gets in the way of the undercutting machine, or the undercutting machine gets in the way of your loader, and that causes delays. I believe that where the conditions will permit it is desirable to put in a cutting machine that will both undercut and shear and drill. In that way you have less equipment on your tracks and less possibility of interference of your equipment with each other."

***MR. S. W. FARNHAM,*** *Goodman Mfg.. Co., Chicago, Ill.:*

"Dr. Fyke's description of the snub and removing of the Illinois blue band brings up to my mind an experience that we have had in cleaning a band of coal midway in the seam in a certain mine, where the rock parting became unusually hard so it could not be cut with a machine profitably. A slabbing machine was used to cut the coal immediately above the band, which in this particular mine ran occasionally to over 30 in. in thickness.

"After cutting immediately above it, the coal below the band was drilled, and the end of the drill holes run into the rock. A crew broke up the band by shooting it. The slabbing machine, meanwhile, would be cutting in other places. When the smoke was clear, the machine came back to this room and inserted its bar in this mass of shot rock and raked it out to the floor. This was loaded out by a loading machine and then the kerf was carefully cleaned and the coal drilled for shooting and the same loading machine then loaded the coal on the night shift.

"Referring to the question of shearing, I might say that we are doing some development along the shearing line in two directions. One is on a machine mounted on a truck which is self-propelling, where it cuts into the center of the track, and therefore in the center of the working place. We are also working with another which is caterpillar mounted and which shears both ribs if desired. That same machine can, of course, be placed in the center of the room and shear the center.

"Just recently we had a comparison of the amount of explosive required in working 18-ft. wide places in a 75-in. seam of coal. Where the coal was undercut only it required in the two drill holes from 70 to 80 in. of double F black powder. Where we center sheared only the amount of powder required was 46 in. Where we sheared both ribs and after the coal was undercut, placed one hole in the center at the top of the coal, only 22½ in. of powder was used.

"The statement has generally been made, I think, that center shearing reduces the amount of explosives required approximately one-half over what it does with undercutting. That figure, of course, varies with the different mines and different conditions. But we have a very clear indication in this one test that there is still much further progress to be made if double rib shearing is done in addition to undercutting.

"The rib shearing that has been done in some cases has gripped to the right and to the left in the entry and formed a wedge shape which does not make the shooting as easy as it might be. This machine under consideration shears exactly parallel and even with the entry rib, and we believe it will greatly facilitate the shooting of the coal. I do not think it necessary to go into the general advantages of shearing as they have already been mentioned this afternoon. They have been mentioned today as chiefly aiding mechanical loading in many cases. We have, however, of late found shearing machines could be advantageously used where coal was simply hand loaded. The increase in the size of the lumps, the hardness and quality of the lumps were particularly noticeable."

# CONVEYORS AS APPLIED TO LONG WALL MINING

*Average Cost Of Operation And Maintenance Three Cents Per Ton—Conveyor Units Moved Once Or Twice A Month Only—Cutting, Timbering And Moving At Night; Loading By Day—Roof Brushing Discontinued*

By D. A. THOMAS*

THE advanced long wall system was first systematically worked in Alabama in 1906 at Aldrich on the Montevallo Seam. This seam averages 32 in. of coal and 18 in. of parting, there being 8 in. of bottom coal and 24 in. of top coal.

This mine was opened in 1885 on the room and pillar system and was converted to advancing long wall system in 1906, the slope at that time having advanced better than 2,400 ft. The first long wall system adopted was the continuous face with individual tracks approaching the face 40 ft. apart, but as this property had but a very limited basin, of no more than 200 ft., this system had to be abandoned as the seam began to rise on about a 12-percent pitch, and it was impossible to get the cars placed at the working face. In working the continuous long wall system considerable expense was encountered in the amount of roadway brushing necessary to clear a car of sufficient. height to move an economic tonnage.

After attempting to work a face track system on 300-ft. panels, advancing, it was necessary to adopt some conveyor system to overcome the very unfavorable grades. In 1917 a drag chain conveyor was introduced in this mine and was worked for five years when this class conveyor was replaced with the reciprocal or jigging type. The principal objection to the drag chain conveyor was the fact that it could not be taken apart and moved forward after loading out each cut, which necessitated the removal of the face row of timbers in order to move the conveyor and which kept the roof in a more or less disturbed condition at all times. Another objection to this type in this particular operation lay in the fact that it was very difficult to get a flight attachment that would scrape slack and fine coal, while the conveyor was practically level without the chain riding the pan and building up a bed of fines in the bottom of the pan.

### JIGGING OR RECIPROCAL TYPE CONVEYOR

In 1921 one of these conveyors with motor was purchased from Mavor and Coulson, of Glasgow, Scotland, but its design was found to be too light to withstand severe service. Several others were constructed on this model by a manufacturing concern in Alabama.

### DESCRIPTION OF CONVEYOR

A conveyor unit for this operation consists of 325 ft. of pans each 9 ft. in length, except the drive or head pan, which is 13 ft. long, an engine equipped with a 30 H. P. shunt wound 1,000 r. p. m. 250-volt, d. c. motor, jack shaft, quadrant or right-angle drive and a 9-point R-32-K controller. The drive is from the discharge end with the drive unit placed in the gob at right angles to the conveyor. The drive is with a ⅞ in. 6 by 37 plow steel rope. The pans are less than 7 in. high, 23 in. wide at the top, 10¾ in. at the bottom with flared sides and are made from 3/16 in. sheet iron. The sides of the pan are reinforced by a strap iron ¼ in. by 2 in. The pans are connected with a 1 in. by 7½ in. bolt with a cold pressed hex nut. The rollers are 8½ in. in diameter, shrunk on 1¼ in. axles. The floor cradles are 18 in. long and are made out of angles 2 in. by 2 in. by ¼ in. The conveyor operates at 60 strokes per minute with variable strokes 7 in., 8 in. and 9 in. However, we do not find it necessary to operate on more than the one stroke of 8 in. A conveyor of this length loaded with mine run coal of which 65 percent will run fancy lump over a 4-in. screen holds about 6 tons, but will discharge at the rate of 1 ton per minute, or as fast as it is possible for 10 to 12 loaders to load.

### HEADING CAR LOADER

To eliminate the necessity of brushing the bottom of the roadway in order for the conveyor to discharge over the top of the car, a heading car loader has recently been installed which is proving very satisfactory. This unit receives the coal from the discharge end of the shaking conveyor and elevates it over the top of the mine car 43 in. This elevating conveyor is 9 ft. long, stands 5 ft. high on the roadway and 1¼ in. on the receiving end on the floor bottom. The pan is 24 in. wide with 6 in. side plates. It operates with a combination chain with cross flights and is driven by a 5 H. P., compound-wound 1,150 r. p. m. motor with spur gear reduction drive. The chain speed is 141 ft. per minute. The motor is suspended directly underneath the pan and attached to the frame support of the conveyor. This conserves space and makes the unit much easier to move. This unit is operated by an automatic starter, the wiring connection being made to the controller which operates the shaker conveyor. This unit can not operate without the shaker conveyor being in running motion, and this is run continuously while a trip of 10 cars is being loaded, as the stopping is done by the heading car loader while each car is spotted. This removes the necessity of stopping the shaker each time a car is spotted, for the elevated part of the heading car loader prevents the coal from coming forward further than a certain position.

In the operation of five of these units the mechanical and repair upkeep, including shop work, average 3 cents per ton, which also includes the drive ropes.

### GENERAL REMARKS

The conveyor drive unit is not moved more than once to twice a month unless roof conditions become so unfavorable as to necessitate moving more frequently, there being 100 ft. of drive rope to each unit. The engine runway is located between two rows of cribs set 5 ft. apart and about 6 ft. from the roadway. After moving forward, this engine runway is gobbed in order to get the benefit of additional pack along the roadway. A wall crew at this operation consists of the following: Day shift—1 face foreman, 10 to 12 loaders (40½ ft. of face in normal coal being allotted to each first-class loader; he handles an average of 12 tons of coal per shift and gobs 6 to 8 tons of dirt), 1 timber man, 1 conveyor upkeep man, 1 conveyor operator, 1 car racker (this man also operates heading car loader), 1 crib man, 1 air-course man, an average of 20 men on the day shift. Night shift—1 face foreman, 1 machine runner, 1 scraper, 1 jack setter, 2 gobbers, 3 timber men, 2 conveyor movers, an average of 11 men.

Coal is loaded only on the day shift, the cutting and moving being done on the night shift. The daily tonnage per wall will range from 120 to 150 tons per shift according to the variation of the seam's thickness. The coal is shot down only as needed with 1¼ in. by 4 in. permissible powder, the holes being placed no nearer than 6 to 8 in. of the roof and not more than one stick of powder used in each shot. A wall will not average in consumption more than 25 to 30 sticks of powder per day.

All timbering other than emergency timbering is done on the night shift, there being two to three men engaged in this work setting timbers on 4 ft. centers. As the cutting advances on the night shift, the conveyor is moved between the first 4 ft. rows of timbers next to the face, which enables the loader to load the cut with as little coal passing as is possible. The mining machine is equipped with a 4-ft. cutter bar. However, bars ranging from 4 to 6 ft. were tried, but it was found that a 4-ft. cut is all that can be consistently cleaned up each shift. This also insures better roof control. The machine is of long wall type and is mounted on an adjustable sled at the proper height to cut the parting. There is a machine for each wall, cutting in one direction in one shift and in the opposite direction the next shift. The cutting is done only in the parting, which is very hard at times, requiring from 6 to 10 sets of bits for cutting a wall of 325 ft. Bug dust, dirt and rock are gobbed over behind the conveyor, which, under ordinary conditions, is sufficient to furnish about 75 percent gob, although at times this runs as low as 30 percent. When the gob is scarce, soft cribs are scattered about in the gob to act as a cushion in the weight settlement. When the gob pack is inadequate to fill the space it has been found necessary to carry a row of breaking cribs within 12 ft. of the face to insure the weight not advancing to the face too rapidly. In such a case the gob timbers are cut to within three rows of the face, but where the gob is sufficient to practically fill the worked-out area, the timbers are not cut. Timbering is done with 5 and 6 in. diameter posts set on 4 ft. centers with no recovery of the timbers. Cross timbers or straps 1 in. by 4 in. are used to take care of light material.

Until the installation of the heading car loader all roadways were brushed 4 ft. in the bottom, but this is now being discontinued. The brushing of the roadway caused bad roof conditions along the roadways, owing to the fact that the bottom rock disintegrated by exposure and crumbled, making the foundation weak. The headings are driven 16 ft. wide and

* President, Montevallo Coal Mining Co., Birmingham, Ala.

with the heading loader will be of pack wall type, there being a 6-ft. pack wall on the rib side of the roadway opposite a wall. The wall side will have one row of roadway cribs with a pack wall on the inside.

Overlying the coal there is from 30 in. to 15 ft. of draw slate, above that 50 to 100 ft. of sandstone, and then above that 100 to 125 ft. of conglomerate. The total cover varies from 450 to 800 ft. Weight begins to show usually within 4 to 8 ft. of the face and is perceptible from 25 to 50 ft. from the face where the roof action can be seen coming down. Breaks usually occur every 200 to 600 ft., unless a slip is encountered in the sandstone. The sandstone, where the draw slate is from 10 to 15 ft. thick, will break after the draw, and in some cases has stood for 600 to 800 ft. When these breaks occur, it usually gives bad roadway conditions for a few days or until the roof settles, and we believe that this is occasioned by the bottom brushing as the weight often pushes timbers through the bank, causing the ribs to fall along the roadway, which, in our opinion, can be entirely eliminated by a pack wall being built along both sides of the roadway and not take any bottom brushing. The roadway grades vary from 2 percent to 10 percent, the haulage being with hoist engine and rope. The walls pitch in favor of the discharge of the conveyor at from 1 degree to 10 degrees with an average of 6 degrees. Some have been worked with as much pitch as 15 degrees. Within the past year it has been found necessary to drive three walls to the dip with a pitch from 10 to 15 degrees. The conveyor, in this case, discharges at a pitch of about 1 degree. The type conveyor used at this operation will not satisfactorily discharge coal while operating level. In the operation of the dip walls a great deal of care has had to be exercised in roof control, for our experience at first in mining to the dip was very costly, first by having the sand rock immediately on the coal and an absence of gob material. It was in this part of the mine that the hardwood face cribs saved the equipment on more than one occasion. During the period of 1906 to date, in this particular operation, there has been mined out approximately 520 acres, with an approximate yield of 4,000 tons per acre, giving a recovery of from 96 to 98 percent.

During the period of November 1, 1923, to May 1, 1927 (the only period that an accurate record of lost cuts has been kept), there was produced 499,756 short tons of coal, with 16,200 ft. of advancement during this period. This is equal to an average of four full-wall operations at 114 tons per day per wall. During the past year we produced in 310 working days 171,000 tons of coal with five walls being in operation. During this period six walls came in, one which was not reopened on account of the territory ahead being very limited. The other five walls had the following experience: August, 1925, four conveyor pans lost, two full cuts lost, taking six days to reopen. The cause of this fall, in our opinion, was due to the wall being operated on two loose ends without sufficient regard being given to the creeping weight. August, 1925, five conveyor pans, two full cuts lost, six days to recover. This fall was caused by a slip in the sand rock. July, 1925, 20 conveyor pans lost, one driving engine, eight full cuts lost, 20 days to recover. This fall, in our opinion, was caused by a slip in the sand rock and scarce gob. October, 1926, 20 conveyor pans, six full cuts, 17 days to recover. This was the same wall that came in July, 1926, and was dip working. January, 1927, 14 conveyor pans lost, six full cuts lost, 17 days to recover. This was on a dip wall, and our conclusions are that the same reason prevailed here as did in the other dip walls in this part of the mine. During the period shown we have lost 24 full cuts, taking 66 days to recover or reopen the walls and losing one driving engine and 86 conveyor pans with cradles and rollers. The mine is operated on an average of 310 days per year, having only three holidays—Christmas, Fourth of July and Thanksgiving.

The method of reopening a wall is to take a 30-ft. slab cut with a machine parallel with roadway and follow this with the conveyor unit. An average of six 6-ft. cuts have been made in a day. A row of cribs are placed under the lip of the roof immediately on the inside of the break, and these cribs are continued until the wall is then operated in its normal position.

The subsidence of the roof comes to rest in three years and is about two-fifths of original height, which leaves our entries about three-fifths of original height. After the subsidence comes to rest, we do not have but very little trouble with roof falls, and especially is this true in that part of the mine where the bottom brushing has not been done.

The advantage of conveyors as applied to long wall in this operation is clearly proven by the fact that many unfavorable grades have been overcome with a maximum recovery of coal and with concentrated mining. This also insures maximum percentage of domestic sizes, our production running 67 percent lump over a 3½ by 4½ in. screen, 10 percent nut and egg, 8 percent chestnut, 15 percent ½-in. slack.

Other practices are employed in advancing long wall and panel long wall system in this state with several types of conveyors, including Eichoff and drag-chain types, with walls ranging from 100 to 200 ft. in length.

Mr. Thomas, in closing his remarks said:

"I would like to add that the approximate cost of the lost material in this operation during the 3 years mentioned was $3,500. Breaking the roof behind the conveyor, or within whatever number of feet you think you need, between the face and a breaking line to give you conveyor room and your workman sufficient space, is very interesting.

"We have successfully broken our roof by using hard wood cribs, placing them and keeping them placed by moving forward at the end of each shift, and before a fresh cut is made, to within 12 ft. of that fresh cut. About 3 weeks ago we had an experience that led us to believe we were on the right track in that regard. On a face working on a pitch averaging from 8 to 10 degrees supported by cribs, the sand stone had not broken for 8 months. In that particular part of the mine we had worked 3 walls averaging 325 ft. in length and advancing 4 ft. a day, 6 days a week. To guard against accidents and a possible loss of equipment in these dipped walls we were carrying these hard wood cribs. The break came and it lasted for better than 4 hours before it quieted down. It was broken off on the outside of these cribs. We saw very little weight on the coal face and very little material coming down."

In opening the session ***MR. DICKINSON*** made a statement about conditions in Wyoming, and the work his company, the Union Pacific Coal Co., is doing there. In part he said:

"There are two distinct fields, the northern and the southern, and they are again subdivided. We, at the Union Pacific Coal Co., are only doing a part of the mechanical loading work that is taking place in the State of Wyoming. Mr. Edward Bottomley, who is with the Sheridan-Wyoming Coal Co., in the northern part of the state is doing some very admirable work.

"Dr. Young, in his discussion yesterday, spoke of the increase in the amount of coal being loaded by mechanical devices underground in the United States. I know that you are familiar with the increase. In the State of Wyoming in 1925 there was loaded 500,000 tons by mechanical means. In 1926 that had increased to 1,500,000 tons and it is rather apparent that in 1927 there will be something in the neighborhood of probably 2,250,000 to 2,500,000 tons loaded by mechanical means. It is true that the natural conditions of the coal beds in Wyoming lend themselves quite agreeably to mechanical loading. This, I realize, is not altogether true in other fields of the United States in which I have had some small measure of experience.

"There are quite a number of devices used in Wyoming for loading coal mechanically. There are the Thews, the underground large shovels, and the various kinds of conveyors, like Link-Belt and the Eickhoff conveyors.

"We have learned that mechanical loading can be carried on with some measure of success under quite poor roof conditions. For instance there is one place where there is an average of 10 in. of bony, which must be discarded and we are cross barring 2 bars to every cut and lagging and still we are getting along. In fact, the results are quite gratifying in comparison with the contract method previously used."

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At a meeting of Kentucky bituminous operators' local association officials, at Lexington, May 7, there was discussion of the cooperative study of accidents at the face in coal mines which has been underway in West Virginia for the past year. Suggestion that a similar study be inaugurated in Kentucky will be presented to the various associations for expression of opinion. J. W. Paul, of the U. S. Bureau of Mines, who was present, explained in detail the West Virginia study and offered the cooperation of the bureau for a similar study in Kentucky. W. H. Jones, chief mine inspector of Kentucky, expressed approval of the idea of such an effort in Kentucky.

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The Lehigh Valley Coal Co. is erecting a $250,000 modern boiler plant at its Franklin mine in Wilkes-Barre, Pa. Three boilers are being installed, each having a pressure of 200 pounds. One of the features of the new plant will be the suspension coal bunkers and automatic stokers. The foundation for the new plant has already been laid and by matic stokers. The company expects to have the new boilers in operation by the end of the summer.

# CONVEYORS APPLIED TO ROOM AND PILLAR MINING

*Grades Vary From Three To Fifteen Percent—Education Of Men To Mechanization Idea Essential—Concentration Of Large Tonnage From Small Area Achieved—Pillar Extraction Facilitated—Day Wage With Hours On Tonnage Satisfactory*

By F. H. COLEMAN*

IN JANUARY, 1926, Graff Bros. placed an Eickhoff jigging conveyor in operation. Units have been added from time to time since then, until at present 13 conveyors are at work in four operations under varied mining conditions. Entries are being driven, rooms advanced to their limits and the pillars extracted; and pillars extracted in rooms which had previously been driven. The thickness of the coal seams vary from 36 in. to 72 in. The flattest seam has a maximum grade of about 3 percent; the greatest grade is approximately 15 percent. Roof conditions are excellent in places and extremely poor in others.

Although the conveyors as a whole have shown a saving from the beginning, the work done has been considered as an experiment, which will produce much greater results in the future. It is my belief that every operation which intends to mechanize to any extent must undergo an experimental period. Even where mining conditions are practically the same, our experience has been that each operation must do its own experimenting. In this respect the matter of educating miners to the new conditions is the biggest problem. More will be said about this phase later.

The purpose of Graff Bros., as well as a great many other companies, has been to concentrate—to mine a large tonnage from a small area. Transportation is the most important item in concentration. To be successful there must be a steady flow of coal from the working faces at a low unit cost. The Eickhoff conveyor was chosen to meet this requirement and put to work on the room and pillar system of mining. The room and pillar system is used because it is the only method of mining in the district that has proven successful over a period of years. We have been able to take liberties by mining with conveyors, however, which are not practical in our conditions by the slower method of loading into cars at the face. For example, pillars are extracted open ended by use of the conveyor, which we were not able to do before. Therefore our system of mining may be gradually changed, but no radical changes are contemplated.

The general method of driving rooms and extracting the pillars that has been found most successful is as follows: Rooms are necked 10 ft. wide on the loading entry on 240 ft. centers at right angles to the entry. If the coal is less than 60 in. in height, roof is shot down, or bottom taken up in the neck of the room in which the conveyor is to be placed, in order to make head room for the conveyor drive and for the loading end of the conveyor. The conveyor is placed about 2 ft. from what is to be the straight rib, and the room driven 10 ft. wide for 30 ft., when it is widened to an average of 25 ft. This width, of course, is varied with different roof conditions. A portable conveyor, which discharges into the main conveyor, is placed parallel to the face after the room is widened. The main conveyor is kept up to the face by attaching a 6½-ft. section of conveyor every second cut, then removing this section after the cut has been loaded out and attaching a standard 13-ft. section. After the room has been widened, a branch room is started on the straight rib side parallel to the entry and so as to leave a 30-ft. entry pillar. This room is also driven 10 ft. wide for 30 ft. and is then widened away from the entry to a width of 25 ft. A branch conveyor, which is driven either from the main conveyor by a swivel drive, or by an independent drive, is placed about 2 ft. from the straight rib, and a portable conveyor placed along the face, after the room has been widened. By this method two working faces on which two loading crews may be employed are available in a short time after the conveyor has been installed. When the branch room has advanced 60 ft. a cross cut is driven to the entry for ventilation. Auxiliary fans are not depended upon for the normal ventilation and are only used in some instances to clear the smoke out quickly after a face has been shot down. The room is stopped when it has advanced 120 ft. and the conveyor removed. In the meantime the main room will have been advanced and another branch room turned similar to the first one, except that only 25 ft. of pillar is left between the two rooms. After the second branch room has been driven 120 ft., the pillar is extracted open ended to within 30 ft. of the main room by the use of the portable conveyor. This procedure is continued until the main room has advanced 300 ft. Branch rooms are then started from the top and on the opposite side of the main room and the pillars entirely extracted. Before the sections of conveyor next to them are removed, the pillars, 30 ft. in width, that were left for protection on the advance, are removed with the portable conveyor.

The equipment is kept along solid ribs of coal as much as possible to avoid danger from roof falls. It is a strange fact that most of our trouble in this respect has been when driving in solid coal and not in extracting pillars. When the room in which our first conveyor was installed had only been driven about 50 ft., a very dense slate 6 to 8 ft. in thickness, with a smooth parting at the top, let go, and the equipment was removed barely in time to keep it from being buried. In another instance we were not so fortunate. A room had been driven to its limit and the pillar being cut off preparatory to extracting, when a similar slate fell for a distance of 50 ft., burying the mining machine at the face and several sections of conveyor. Posts had been set on an average of about 3-ft. centers over the entire area. The mining machine was removed without being damaged by driving a narrow place from another entry. Two sections of conveyor, however, were damaged beyond repair.

Many pillars have been recovered with the conveyor from rooms that had been driven and left standing for a great number of years. This is done by placing the main conveyor on the entry, running a branch conveyor along the straight rib and bringing it back open ended by the use of the portable conveyor.

Only one injury has been recorded on the conveyors during the 15 months of operation, and that was avoidable. A miner, strictly against orders, attempted to move the cutter bar of a mining machine with a small bar while the cutting chain was in motion, with the result that the small bar was run into his abdomen. He recovered in a few weeks.

A loading crew at the face consists of three men, who do all the work required to mine the coal. Four and five man crews have been tried, but it has been found that the smallest crew is the most efficient. Two and even three crews, however, may load into the same main conveyor, with only one man at the loading point on the entry. Besides loading the cars and starting and stopping the conveyor, the duties of the man on the entry are to see that all machinery is oiled and in good running condition, and to take posts and other supplies to the working faces.

Where at all possible, two shifts have been worked on the conveyors. This has been done for two reasons. First, because better mining results are obtained when the coal is extracted quickly; and, second, and to me the more important, because larger returns are made on the investment. It is certainly an economic waste to place expensive equipment in a mine which is available for duty 24 hours of the day, and then allow it to lie idle two-thirds of the time, which is the case when only one shift is worked. This is not only true of conveyors and mechanical loading equipment but of the entire mining plant. I do not believe there is another industry with so great an investment for the risk involved and the returns received that gets as little use from its equipment.

Records have been kept of the performance of each conveyor, but unless the conditions under which they have been working are known the figures are likely to be misleading. For example, during March of this year, conveyor IW, with three men at the face and one on the entry, loaded 2,304 tons in 45 shifts for an average of 51.2 tons per shift. During the same period and with the same number of men, conveyor IB loaded 1,318 tons in 43 shifts for an average of only 30.7 tons per shift, yet showed practically the same result financially as conveyor IW. It is therefore considered that the figures alone would not be of much practical value.

There is one phase, however, that should be considered very carefully—the human element. Miners as a whole are apt to be skeptical of any new equipment or any change in working conditions. It was with difficulty that a crew was found that would work efficiently on the first conveyor put into operation,

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and the same difficulty has been encountered on every installation since. At present there is not a sufficient number of men available who can and will work on the conveyors installed, and get the results that should be gotten. There are, however, quite a number of men who have become very efficient and who really prefer work on the conveyors to other methods of mining, and it is believed that it is only a question of time until there will be a surplus of men of this class, even though a slow process of education is necessary.

We are attempting to make the work on the conveyors as attractive as possible, both financially and otherwise, and still show a profit on the investment. At the beginning, all work on the conveyors was paid for on an hourly basis, but when the men had become sufficiently familiar with the work and were producing a fair amount of coal, a tonnage rate was put into effect on a sliding scale basis. The rate per ton was small for the first few tons, and, as the tonnage increased, the rate per ton increased in proportion. Unfortunately, the rate was too low for the men to make a fair wage, and, of course, was abandoned. The men now looked upon this work with suspicion, and, in order to overcome it, a day rate higher than any other in the mine was established, and a small bonus offered for each ton over a certain fixed tonnage. More men were soon available than were needed and excellent crews were selected in all cases. Under these conditions more men became familiar with the work and very good results obtained from an educational standpoint, but fundamentally the rate was wrong, because there was not sufficient incentive to produce a large tonnage. The present method of payment is a compromise between previous methods. A day rate smaller than the average in the remainder of the mine is paid and a substantial bonus is given per ton for all coal over a fixed amount. This fixed tonnage is low enough that it may be reached without much effort. The bonus is on a sliding scale; that is, the higher the tonnage produced, the greater the bonus per ton. When this rate was put into effect, the men remembered the former experience of working on a tonnage basis, and we were again short of men, but this difficulty is being slowly overcome, and in the near future we will be able to further expand our operations.

After the transportation problem has been solved, the next step, and I consider it of minor importance when compared to transportation, is a method of loading the coal at the face mechanically. A conveyor does not meet this requirement. Our observations have shown that, considering the actual shoveling, a man can load only about 10 percent more coal into a conveyor than into a mine car. The saving on a conveyor operation is based almost entirely on the men being able to load coal a greater proportion of the time. It is my opinion that if a large number of men can be concentrated in a small area with few interruptions in the flow of coal from the working faces, there will not be a great difference in total production costs, whether the coal is loaded by hand or machine.

***MR. E. B. GELLATLY,*** *Gellatly & Co., Inc., Pittsburgh, Pa.,* led the discussion following Mr. Coleman's paper. His remarks follow:

"We are all more or less familiar with the so-called conveyor systems which the Graff Brothers have been using. There is no question about the practicability of the conveyor. That it produces economic results can be attested to by many operators. By economic results I mean that when all the direct and indirect costs, labor, power, maintenance, interest on investment, etc., are taken into consideration, the cost per ton of coal on cars at the face or tipple is such as to show not only a substantial, but a satisfactory savings over the hand loading methods. I do not mean to infer that the conveyor can be placed indiscriminately in any mine without first considering such items as the production cost, production per day per loader, labor conditions, etc., but where conveyors have been introduced in various mines under widely varying conditions in Fennsylvania, West Virginia, Ohio, Kentucky, Virginia and other eastern, as well as western states, the results obtained have been almost universally successful. In some mines results have of course, been more gratifying and profitable than others, but this condition is only natural. Instances where results have not been at least profitable are rare if they exist at all. None such instances have come to my attention.

"With the conveyors we have numerous advantages over hand loading which I shall enumerate briefly. If I become too enthusiastic in my remarks, I shall be glad to be corrected by those who have had experience with this particular type of equipment. I would sum up the salient points as follows:

"*First:* Increased tonnage per man per day. This gives the operator the direct benefit of having smaller organizations of labor to deal with, reduced capital expenditures and lower compensation expense by reason of fewer accidents accountable directly to the smaller number of men employed.

"*Second:* Reduced labor cost per ton of coal produced. This is effected chiefly by reason of the ease with which the men perform their work, as compared with the hand loading, resulting in a greater production per man with the same physical effect.

"*Third:* Concentration of mine workings, the advantages of which we of course all know. Much larger tonnages are produced from the working faces automatically reducing the extent of the working areas for a mine of a certain rated capacity, reducing materially the difficulties, consequently the cost of haulage, drainage, ventilation, as well as the advantages gained and the reduced cost of track work, timbering and other dead work.

"*Fourth:* Continuation of the room and pillar system of mining is preferable for economic or other reasons. While the conveyor has been applied to long wall work, the major number of the installations have been applied to room and pillar work. In the room and pillar work various combinations have been used relative to: Width and length of room, width of rib, method of extracting ribs, etc. These are all necessarily controlled by local conditions. However, a *distinct advantage* is gained by not having to change from an old established system to a radically new or different system.

"Conveyors are being used extensively for entry development purposes to which they adapt themselves effectively and economically. They have also been used advantageously in connection with rock disposal, many unique installations having been made and still operating.

"Capacities vary from 10 to 60 tons per hours depending on the size of pan. High recovery of pit posts are often secured. Mr. Haworth, of the Hillman Coal & Coke Co., informed me upon inquiry, that he had investigated mines which consistently recover 75 percent and better of the props used in the rooms.

"Accidents are noticeably few. Very rarely do we hear of accidents in connection with conveyor loading."

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## CLEANING WEST VIRGINIA COAL

(*Continued from page* 431)

"By substituting the light impurity for the heavy there results a product consisting of 90 percent coal at 4.5 percent ash, 1 percent heavy impurity at 70 percent ash, 9 percent light impurity at 20 percent.

"The ash content by this substitution is reduced from 10 percent ash to 6.55 percent. This is a straight substitution, hence there is no loss nor any gain in the amount available for shipment.

"The guarantee on this coal, however, is 7 percent ash and as the coal is below that point it will stand a further addition of the light impurity. The amount which may be added is 3 percent. There then results a product consisting of 87 percent coal at 4.5 percent ash, 1 percent heavy impurity at 70 percent ash, 12 percent light impurity at 20 percent ash. The ash content by the substitution is reduced from 10 percent to 7 percent and there is 3 percent more fuel available for shipment than originally.

"The increase of product must be credited to the cost of treatment. Taking the average value of the coal treated at $2 per ton this increase amounts to 6 cents per ton or an amount which about covers the cost of cleaning. Additional credit must be allowed the cleaning process, for the higher price obtainable on account of a lower ash content, the better market provided, steadier operation which means lower mining costs and the improvement in efficiency resulting from better relations between employer and employe.

"Another interesting point which developed in this plant is an increase in the fusion temperature of the ash of the treated product over the crude coal. The fusion temperature of the ash of the coal is 2,611 degrees. The fusion temperature of the ash of the light impurity as 2,850 degrees which makes it a better steam coal.

"This condition to a greater or less extent applies to practically every mine. The controlling factors are the quantity and quality of light refuse now being discarded, the quantity and quality of heavy impurity in the fines, the quality of the pure coal and the guarantees to be met. *Guarantees:*

Within 1½ percent inherent or fixed ash depending upon conditions, character of coal and impurity in cases not over 0.25 of 1 percent loss of good coal.

Not over ½ percent as high as not exceeding 1 percent."

# SCRAPER LOADERS APPLIED TO MODIFIED LONGWALL FACES

*Long Working Faces Found Essential—Special Attention Paid To Roof Control — "V" System Adopted—Production Per Eight-Hour Man-Day In Excess Of Twelve Tons—Production Directly Proportional To Coal Height*

*By* S. W. BLAKSLEE *

THIS paper deals with the experience of the Pennsylvania Coal and Coke Corporation with scraper loaders working on "V" faces in coal from the Upper and Lower Freeport and the Lower Kittanning veins of Central Pennsylvania. Since July, 1924, over one-half million tons of coal have been scraped at three of our operations. The coal ranges from 32 inches to 44 inches in thickness.

During 1917 scraper loaders were first installed by the Corporaton and used on a slight modification of the room and pillar system of mining, but did not prove economically successful. The newly developed equipment was somewhat faulty, labor was very independent, and some of the local mine managements were rather reluctant about trying anything new. The principal reason, however, for its failure was because of too much laborious "deadwork" involved in scraping coal from room faces which were from 25 ft. to 40 ft. wide. Extracting room pillars reduced the "deadwork" considerably as by "slabbing" pillars between cross-cuts all shoveling of coal was eliminated, man-handling of the scoop was lessened, and the arrangement of the ropes and sheaves was greatly simplified. The savings effected in pillar work, however, did not sufficiently overcome the expensive advance work cost and so after two years of experimenting the scrapers were abandoned.

With the knowledge that coal could be loaded at an appreciable reduction in labor cost if longer faces could be worked and the scoop travel confined to practically a straight line, a second attempt was made in 1924 to mine coal with Scraper Loaders. This new venture was not as much of a mechanical loading experiment as it was that of roof control. It was decided to work a face 135 ft. long and the problem to solve was that of keeping the face open.

The face (Figure I) was developed by connecting two entries that had been driven on 145 ft. centers at right angles to a panel entry. The face was parallel with the panel entry, 400 ft. from it when scraping began, and retreated towards it. Two scoops were used in the opertion—one scraped along the face to one of the lateral entries and the second picked up the coal where deposited by the first scoop and carried it to the mine cars in the panel entry.

This system was not in operation long—the face retreating but 80 ft., when it was decided, after careful investigation at Norton, W. Va., to experiment with the scrapers on the "V" system of mining. The "V" system seemed to offer better chances of roof control than a comparatively short longwall face, and if we could work it under our mining conditions a hoist and scoop would be eliminated and the machinery installation greatly simplified.

Our first "V" conformed in dimensions and timber setting and extraction to a Norton "V." To better suit and take fuller advantage of our natural conditions, we later increased the width of the "V," changed somewhat the method of timbering, and found that we controlled the roof action best by leaving a solid but small pillar between "V's."

During the experimental period some 40,000 tons were mined by simultaneously scraping from three "V's" on to a conveyor and loading at one mine car loading point. Theoretically, the cost on this system should have been reduced, but instead it was increased some 8 percent, due to frequent conveyor breakdowns and the inability to synchronize the work of the three "V's" on account of roof trouble.

Before discussing in detail the application of the Scrapers to the "V" system of mining the equipment will be described. It consists of a hoist, a scoop, and sheaves. The hoist is of rugged construction, has two drums, and is

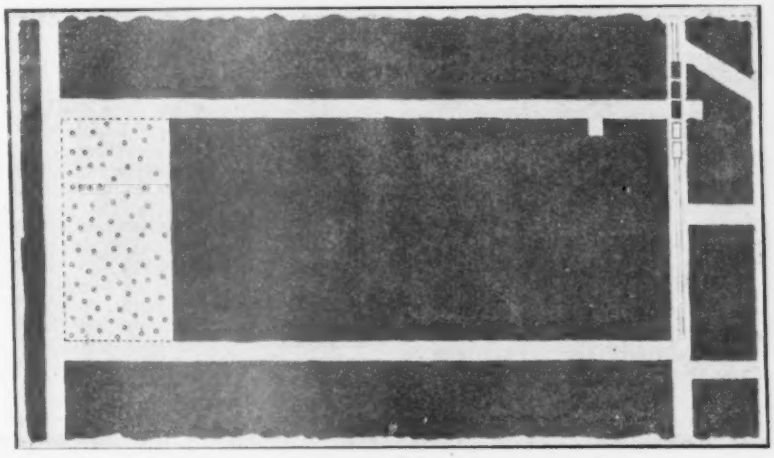


*Figure* 1

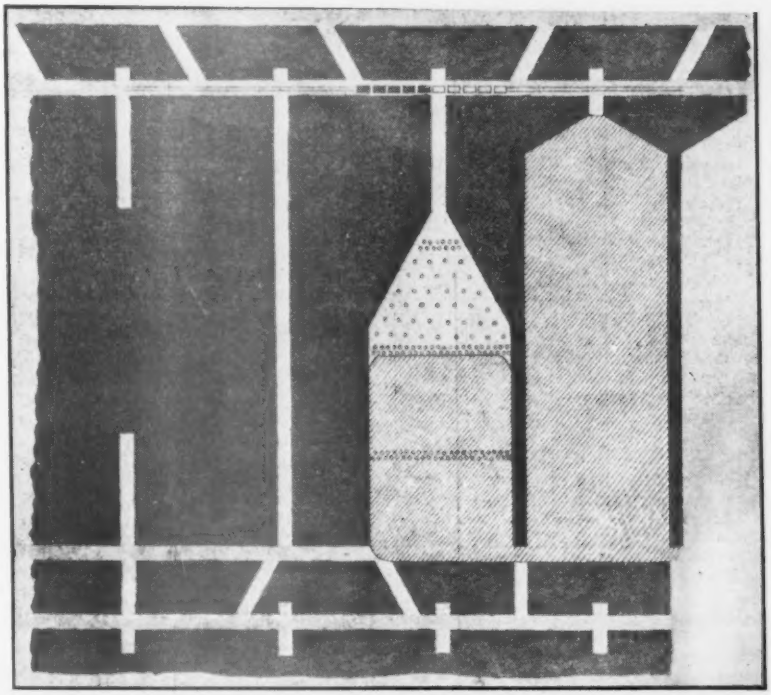


*Figure* 2

* Division Superintendent, Pennsylvania Coal and Coke Corporation.

driven by a 40 H. P. motor. On the pulling drum a ⅝-in. rope is used and a ½-in. rope is used on the tail rope drum. The rope speed is 600 ft. per minute under load. The scoop is steel and is "V" shaped. It weighs 500 lbs. and carries an average load of 1,450 lbs. At the open end the side plates are bent in slightly to keep the scoop from digging into solid coal. To the bottom of the side plates are attached curved steel runners which prevent the scraping of bottom rock. A total of seven sheaves is used—two closed type and five open type. A chute of wooden construction is built in the neck of the scoopway up which the scoop slides in order to gain the elevation required to load the coal in the cars as they pass under the chute.

Figure II illustrates a section of the standard panel at our No. 8 mine where we first applied scrapers to the "V" system. The vein mined at No. 8 is the "D" or lower Freeport. It averages 49 in. in thickness, including a 2-in. slate binder 16 in. from the bottom, and 4 in. of cannelized slate above the coal. The bottom rock is of a hard slate and the top rock immediately above the seam is a very strong slate. Cover runs from 250 to 325 ft. thick. The mine is nongaseous.

A panel consists of a heading and air course each driven 10 ft. wide. Entries known as scoopways, 10 ft. wide and 330 ft. long, are turned at right angles to the panel entry on 125 ft. centers and are connected with the air course of the next panel. This development is made by hand-loading. Only one "V" is worked at a time in each panel but development of several scoopways may be made at the same time.

Scraping begins either at the inby or outby end of the panel and works toward the opposite end of the heading, successive "V's" being scraped. The "V" is formed at the air course end of the scoopway and retreats toward the entry. The air course caves with the first cave in the "V." This does not interfere with ventilation and leaves but two sets of stumps to be removed—the saw-tooth heading stumps and the chain pillar.

The faces are made by slab cutting the ribs of the scoopway until a width of 115 ft. to 120 ft. has been attained at the top end of the "V" and the faces developed to a length of approximately 100 ft. each. This gives a total angle at the point of "V" of from 60° to 65°. A 5-ft. to 10-ft. pillar of coal left between "V's" isolates the caves and aids roof control.

A day's operation consists of loading a 6-ft. machine mined cut of coal from each face. The loading usually requires eight hours but is completed no matter what overtime is worked. Timbering, cutting, drilling, shooting, and some preparation of the coal is done on the night shift. This too requires about eight hours but also is completed before the shift quits.

Cars are placed in solid trips of 35 cars each, entering one end of the heading empty and going out of the other end loaded. This practice has afforded an almost perfect car supply.

The timber used in the "V's" is 6-in. round posts. One row is set on 5-ft. centers and 6½ ft. from the solid coal along each face for each cut of coal taken out. Breakrows of the same material are set at right angles to the scoopway and on from 70-ft. to 80-ft. centers. A breakrow consists of two rows of props set on 2-ft. centers and from 18 to 24 in. apart and staggered. Breakrows are started as soon as the point of the "V" has reached a distance of about 90 ft. from the air course or last breakrow and are set progressively each day until completed. The minimum amount of timber necessary to meet the roof conditions is used, and caves as a rule come without any timber being chopped out. Under normal conditions there are two caves before the "V" is completed, the third and last cave coming after the "V" has been worked out and abandoned. Caves usually stop on the breakrows but in a few instances some faces have been partially lost. Inasmuch as the recovery from areas mined out on this system is from 88 to 92 percent, the loss due to caves is very small, as from 4 to 8 percent is lost in the small pillars left between "V's."

The maximum loading crew consists of six men and a boy occupied as follows: A hoist operator, one car trimmer, one car shifter, three facemen, and a bell boy. Where cars are shifted by a hoist controlled by the car trimmer one man is eliminated, and where but a normal amount of rock is being handled on the faces, either one faceman or the bell boy can be spared. The facemen break down the coal, gob what rock lies exposed, and, when necessary, guide the scoop into the coal. The bell boy, when employed, signals the hoist operator and aids in the gobbing. Timber is taken into the "V" by the loading crew at the completion of its shift. Loading of coal, rather than cleaning of coal is the first consideration of the crew, as the mine's tipple is equipped with facilities whereby the coal may be more efficiently prepared than at the face. The night force of three men—a cutter, a scraper, and a timberman—prepare the "V" for the loading crew. A foreman is assigned to directly supervise the work of the loading crews on two or three "V's."

Monthly production figures show an average daily tonnage per "V" of from 150 to 160 tons. Production per man-day of eight hours is in excess of 12 tons. In arriving at this figure, the cost of direct supervision, all labor repair charges to equipment, and the cost of moving from one set-up to another are all included with the labor cost required to load the coal in a solid trip of cars ready for the main line locomotive to take to the tipple.

To meet the different conditions in the other seams where this system has been introduced it was sometimes necessary to modify the above layout somewhat, change the timbering plan, and also the size of the crew. At the operation in the "E" or Upper Freeport seam where the coal is 34 in. thick with from 1 in. to 3 in. of bony on top and overlaid with from 80 to 350 ft. of cover, the general dimensions of the "V" have remained the same as at No. 8 mine but it was not found necessary to leave the slight pillar of coal between "V's" as is done there. As two 100-ft. faces in this height of coal do not give enough coal for eight hours scooping, it has proven more economical to let a crew of 5 or 6 men complete the cycle of operation. All development work at this operation is done by scoops. Wide entries with angled faces are driven but scoopways are confined to about 12 ft. in width.

In the "B" or Lower Kittanning vein the coal averages 40 inches in height and is overlaid with from 3 in. to 5 in. of bony. The immediate strata above the bony is very tender shale and in introducing the "V's" at this mine it was found necessary to change the system of timbering somewhat and also decrease the width of the "V's." Two rows of split props set on 3-ft. centers replace each face cut removed, and as it is necessary to timber as quickly as the coal is removed a timberman is used on the loading shift which reduces the night force to two men. The "V's" are 90 ft. wide and a small pillar of coal is usually left between them.

At the three operations above mentioned the production per man-day is directly proportional to the coal height.

The advantages of scraper loading on "V" faces, as we have found them, may be summarized as follows:

For the daily tonnage produced, the initial cost of a rugged and simple loading device is small and maintenance cost is very low. As the most expensive piece of equipment, the hoist, sets on the entry, the value of the equipment exposed to any danger due to caves is small and this equipment need not be lost if proper precautions are taken.

In the event that a cave rides a breakrow and part of the faces are lost, new faces may be quickly dedeveloped without moving the equipment or seriously reducing the output of the "V."

Mine cars are loaded without uncoupling the trip or taking them off the entry. Besides indirectly reducing the labor cost, the number of transportation accidents are greatly decreased.

A "V" offers practically 200 ft. of continuous cutting without the usual cribbing, packwall or jacking problems connected with Longwall mining. The timber cost exceeds by 4 cents per ton the cost of timber in room and pillar work.

Two other advantages incidental to the system are:

In mining one-half million tons we have had no fatalities. Two men have suffered broken bones from falls of coal and rock. The cost of compensation at the three mines above mentioned is less than half of the average of the other mines where coal is hand-loaded from rooms and pillars.

The labor turnover has been greatly reduced. Of the original crew of ten men that started with the experiment in 1924, seven are still employed on the scrapers. Of 20 men that were employed on January 1, 1926, at our No. 8 mine, the same 20 men were still employed on December 31 of that year, and these 20 men enjoyed a work opportunity of 307 days for the year.

When compared with room and pillar work where coal is hand-loaded into mine cars, the above described system has three disadvantages:

The amount of narrow work is increased.

Mechanically loaded coal costs more to clean on the tipple.

The amount of "fines" is increased due to harder shooting and the scooping operation. (*Continued on page* 462)

# COMPLETE RECOVERY BY MECHANICAL MINING

***Mechanical Loading Calls For Complete Recovery—Problems To Be Met—Experiments Made—Final Plan Adopted—Timber Recovery High—Roof Control Good—Safety And Low Costs Achieved Where Right Mining Plan Is Used***

By L. C. SKEEN *

DURING the year of 1924 the Fordson Coal Company began experimenting with mechanical loading machines, and on November 1 of that year we installed a Joy Loader in our Banner Fork Mine, in Harlan County, Ky. This mine is in the Wallins seam, has average thickness of 6 ft., is 2,450 ft. above sea level, with cover ranging from 90 to 1,050 ft.

At the time this machine arrived we did not have sufficient territory developed to start any particular plan, and consequently the machine was placed in room work, the rooms averaging 35 ft. in width. The machine was kept at this work until sufficient development was made which would permit us to try out various plans which might possibly be used to advantage.

### IDEA OF TOTAL RECOVERY

In trying to use any machine to an advantage, we decided it was going to be necessary to secure as near complete recovery as possible. This feature presented several problems, such as safety to the operating personnel, equipment, and economical operation under these conditions.

### PLANS TRIED OUT AND RESULTS OBTAINED

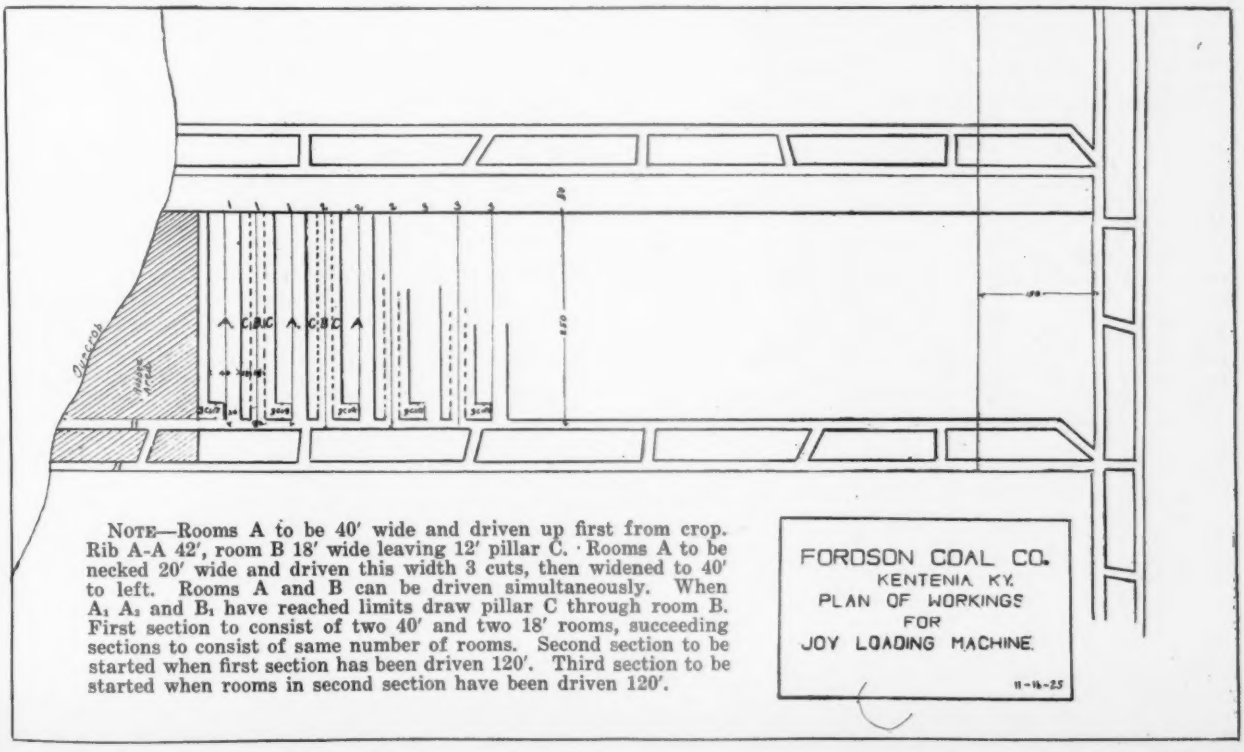
From former work done by hand we were able to extract a block of coal 240 ft. by 280 ft. by retreating open-end work in a period of 26 work days. This led us to believe that if we could reduce the length of face to 200 ft. we would be able to use the loader on these faces. Our assumption was in error, as top conditions immediately became worse, and we were unable to control the roof. We would lose our face with each fall. After numerous trials, using various length faces, and all systems of timbering imaginable, we abandoned the idea of long faces and began to look for some other way to accomplish our purpose.

In one section of the mine, we ran into a roof condition that was rather bad. The coal was overlaid with a rotten draw slate, running from 1 in. to 12 in. in thickness. The top over this section of the mine was comparatively shallow, not exceeding 150 ft., which accounted for the bad roof condition in this section. After running into this condition we thought it would be best to reduce the room width, the idea being to hold the top if possible. After giving the proposition due consideration we decided to take a chance and see what the Joy loader could do under these roof conditions.

We began necking the rooms on this cross entry from outcrop toward the main haulage, on 24-ft. centers, the rooms being driven 12 ft. wide. We were more or less surprised at the results that were accomplished in this work, not from the standpoint of tonnage loaded, but from the way the slate worked. This draw slate would usually hang up over the coal until the cut was cleaned up, then the track and timber men would take the slate down. After these rooms were driven to the limit, we decided to try to remove the pillars in these rooms with the machine. Our idea was to use the machine for the first few cuts, then to finish the pillars with hand loaders. After starting the machine on these pillars we were greatly surprised at the success we had. The rate of extraction was so fast that the top had no time to take on any weight, and we were convinced that this method was safer than where pillars were worked by hand. The machine was double shifted on these pillars, and the results obtained through the use of the machine on this place were very satisfactory from the standpoint of total recovery and safety, but were not so pleasing from a tonnage standpoint. We found that our average daily tonnage on extracting the pillars was almost double that in driving the 12-ft. rooms to their limits. We then began to try to figure out a plan whereby the maximum tonnage with a minimum number of moves of machine could be obtained, thus obtaining a more uniform average daily production.

### FINAL PLAN ADOPTED

The plan adopted and which has given us very satisfactory results is as shown in the accompanying sketch, and is nothing more than room and pillar methods, using varying width rooms and 12-ft. pillars. You will note that entry




NOTE—Rooms A to be 40′ wide and driven up first from crop. Rib A-A 42′, room B 18′ wide leaving 12′ pillar C. Rooms A to be necked 20′ wide and driven this width 3 cuts, then widened to 40′ to left. Rooms A and B can be driven simultaneously. When $A_1$ $A_2$ and $B_1$ have reached limits draw pillar C through room B. First section to consist of two 40′ and two 18′ rooms, succeeding sections to consist of same number of rooms. Second section to be started when first section has been driven 120′. Third section to be started when rooms in second section have been driven 120′.

* General Superintendent, Fordson Coal Co., Inc., Stone, Ky.

is driven to limits and rooms necked from the farthest point away from main haulage on the cross entry.

The first room is necked 20 ft. wide and driven this width for 20 ft. and then widened to the left to 40 ft.; room number two is necked 18 ft. wide, leaving a 12-ft. pillar between number one and number two rooms; number three room is necked 20 ft. wide, driven in 20 ft., and widened to the left 40 ft., leaving 12 ft. of coal in pillar between number two and number three room after number three room has been widened to 40 ft. These three rooms are worked as one section or unit, and the faces are advanced and kept in line. This section is advanced to the limits, and pillars are then extracted in the following manner: Track and timbers are removed from the 40-ft. rooms as soon as these rooms reach limits, and the 12-ft. pillars between these 40-ft. and 18-ft. rooms are taken out by the loading machine, working inside the 18-ft. room. A 30-ft. slab is first taken from the right-hand rib, then one from the left-hand rib, the remaining 6 ft. of coal in the right pillar is then removed, and last the remaining 6 ft. of coal from the left-hand pillar. By working in this manner the machine and operators are protected by coal ribs until all of the second cut on left-hand rib is cleaned up. After all the coal in the first four 30-ft. cuts is loaded out, a second slab is started 20 ft. long, but is only undercut 16 or 17 ft., leaving a 3 or 4-ft. peg, which is not undercut. This is left and is taken out when the second cut on each rib is cleaned up. There is usually just enough weight on this small stump to make it comparatively easy digging for the Joy loader. Leaving this small peg until last gives us additional protection and effects a saving in timber cost. In taking out the remainder of these pillars, the length of the slab is determined by roof conditions. The length of these slabs are usually reduced the farther back the pillars are withdrawn.

You will note from drawing that the first section consists of two 40-ft. and one 18-ft. room, the second section of two 18-ft. and one 40-ft. room. On the first section 79.7 percent of the coal is recovered advancing, and 20.3 percent retreating; on the second section 63.9 percent is recovered advancing, and 36.1 percent retreating; giving an average of 71.8 percent advancing, and 28.2 percent retreating.

Results obtained on this plan have been very satisfying, and have proven best for our conditions, where complete recovery has been the goal. We are securing total recovery with machine loaders on this plan, and this is almost an impossibility where hand methods are used. A saving is effected in the cost of track, timber and dead work, and an increased percentage of recovery is obtained.

Practically all of the timber in 40-ft rooms is recovered, and very little is used in the 18-ft. rooms. We set three props in line with the loose end of the pillars, in order to keep the slate from riding over into the 18-ft. room, in case of a fall.

By taking out the coal clean, and the use of practically no timber, we have been able to control the roof. Another feature about our success of roof control on this plan is due to the fact we began our extractions under shallow cover, which breaks readily, and we get immediate relief from roof pressure. There has never been the slightest sign of weight on the 12-ft. pillars, and it is necessary to undercut them all.

By the use of this method the rate of extraction is so fast that the top does not have a chance to work or give down before all coal is out. If the operation is carefully watched, and things kept properly moving, 100 ft. of these 12-ft. pillars can be easily removed in 16 hours. One hundred linear feet of 12-ft. pillars would mean a 50-ft. retreat on both ribs. All of our work along these lines has been done on a double-shift basis.

To date we have effected an average net saving of 16 percent over hand loading.

### Safety Cost

We have mined 96,533 tons to April 1 with the Joy loader since we have had it in use, and up to April 1 have had one minor injury which resulted in three days' lost time to injured employe. This man was injured by a small piece of draw slate falling on his head, while machine was tramming on the entry. No injuries at working face.

Under our conditions a man who loses one day is termed a minor injury, whether we pay him compensation or not. Our average runs about 6,000 to 9,000 tons of coal produced per miner injured. If we mine 96,000 tons against 6,000, and you are doing it on pillar work, it certainly stands to reason that it can be done. The hazard of mechanical recovery is not as big a bug as most of us once thought.

### Conclusion

From my point of view, I consider this method best adapted to our conditions. This same plan may prove an absolute failure at another mine where conditions are different. The main point that has made such an impression on me is that total recovery can be obtained by mechanical methods where the right plan is used, and can be accomplished at a saving in cost, and with a greater degree of safety to the operating personnel.

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***MR. HARRY S. GAY, SR.**, Gay Coal Co., Logan, W. Va.:*

"At our mine we have had about 20 years of experience in solving some of the problems that have been presented at this meeting. For instance, I had a patented hydraulic post about 20 years ago that I tried out. Finally I came to the conclusion that wooden ones were cheaper. All those things have been discussed more or less on several occasions.

"In figuring what proportion of coal we should mine when we are on a system of that kind, I estimated that we should have, to satisfy the land owners, not less than 75 percent. I started to try a longwall system of mining, but this question of roof control was the one that halted us and made us change it. We had a roof of 30 ft. solid sand slate, or sand stone. When you come to discuss how far back you can support a roof, whether a roof is self-supporting and how far from the face it should be, that always seems to me a question that is solved pretty nearly by the kind of a roof you have.

"Two gentlemen spoke here yesterday. One was positive that it couldn't be done. The other showed that he had done it. When we tried to solve that problem with a 30-ft. covering of solid rock, and we had advanced about 150 ft., the roof stood without a post under it, and it was 300 ft. long. The conclusion we reached was that we'd better shoot it down and get a break started. To do this we set a row of posts 8 or 10 ft. apart, and shot the top down. The roof fell in a solid slab of rock 30 ft. high and there was as much room above the fall as the height of seam. I felt that any longwall system was a failure there.

"I reason that if it was hard to get down it was easy to keep up. We adopted another system which was illustrated yesterday showing where we left a pillar of 25 ft. standing with the expectation of losing it or getting as much as we could from it. We have since then put in a loading machine. That was about 13 years ago. It wasn't adaptable to that kind of work. We took one after another of them. We had 7 different machines in our mine of different makes, and 4 different types, but we are now using a Joy loader and have for the last 3 years. We load about 40 percent of our coal with this one loader and we work night and day. Some shifts we get as high as 500 tons with this loader. We are running about 400 tons out of our mine and about 1,000 tons or better a day.

"We can do a lot with a mechanical loader. For instance we have 20 in. of slate to move, and we cut that slate. That is the advantage of the system we have. We gob that slate over with the Joy loader, and do as much work in 3 hours with that machine as we did with 10 or 15 men in 8 hours. That part is very economical. The loader itself illustrates what can be done with a few men.

"Of course, it isn't all smooth sailing. I can say this that after a period of years we demonstrated that we could get 85 percent of the coal or a trifle above. On the whole we are satisfied with the application of that machinery."

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# MINING IN WYOMING BY MECHANICAL LOADING EXCLUSIVELY

*Large Capacity Cars An Advantage In Mechanical Loading—Day Wage Desirable—Haulage Should Be Maintained At High Efficiency—Mechanical Loading Means Quick Recovery And Concentrated Operations—Experience Highly Satisfactory*

*By* EDWARD BOTTOMLEY*

THE Sheridan-Wyoming Coal Co. is operating two mines in the Sheridan field by mechanical loading exclusively, and one other mine, where 50 percent of it's coal is loaded by mechanical means. It is planned to make this latter mine also 100 percent mechanical in the near future.

### TWO TYPES OF LOADERS USED

The Goodman power shovels are used in rooms or wide work, and the Joy 5 BU is used for all narrow work and for loading room coal when there is an insufficient amount of coal in the narrow work to give them a full day's loading.

Success in this comparatively new undertaking depends on a few prime factors. The men in direct charge of a property contemplating mechanical loading must be competent to decide what type of loader is best suited to their particular mining conditions, and in most cases a thorough investigation of machines on the market and direct observation of their performance under varying operating conditions is necessary, before a final decision can be made.

If the mine is well developed, a plan or system must be worked out for placing mechanical loaders in operation, that will not necessitate radical changes in equipment, such as rolling stock, tipple, etc.

It is a well established fact that certain types of pit cars, of large capacity, are more suitable for mechanical loading than small cars. In a fully developed mine there is usually a supply of cars in use that the company could not economically discard. Then again, the question of enlarging the car capacity to any appreciable extent might necessitate expensive changes in the tipple, and at shaft mines, in many cases, it would be prohibitive to enlarge the size of the shaft. Therefore, it is usually up to the man on the job to make the best of the equipment on hand.

You must be able to "sell" the idea of mechanical loading outright, not only to your organization but to practically all the men connected directly or indirectly with the operation of the machines. This naturally is more difficult in some localities than others, as it all depends to a large extent on the general community attitude and feeling toward the management and company, and on the degree of knowledge of the organization as to actual results being obtained by mechanical loaders in other properties.

### ECONOMIC FEATURES OF EXCLUSIVE MECHANICAL LOADING

It is necessary to point out to those contemplating placing their mines on an exclusive mechanical loading basis, an economic feature that may be overlooked, but which no doubt has been forcibly brought to the attention of those who are already 100 percent mechanized. A large hand-loading mine, working on the regular contract basis at so much per ton, usually carries more loaders for each section of the mine than is required to produce the desired tonnage output.

A mine of 3,000 to 4,000 tons capacity will show from 25 to 50 more men on the payroll than is necessary to load the required tonnage, due to the rather high percentage of men who work irregularly. In a hand-loading mine this irregularity will not seriously affect the tonnage or the cost sheet for any one day, but with a completely mechanized mine loading operations can not be made nearly as flexible. Taking into consideration the cost of mechanical loading equipment, every man in and around the mine should be placed on a day-wage rate basis so that this matter can be effectively controlled. One can not afford to keep an extra loading machine in eacn district and if you could you would not want to carry an extra crew of day men for such emergencies as have been mentioned.

Another thing that has been found necessary to keep a continuous flow of coal going to the tipple from an entirely mechanical loading mine, is to make your haulage roads and rolling stock as nearly 100 percent perfect as possible, in order to get the full benefit of the machines. One hundred percent mechanical mines require a great deal more detailed supervision. Systematic and regular distribution of cars throughout the mine is an all important feature, and engineering skill of no mean ability is required to accomplish the desired results.

### MECHANICAL MINING BEST FOR QUICK RECOVERY

In many fields where the vein of coal is thick and operating time is very irregular, under hand mining methods rooms 250 to 300 feet long require a year or more to reach their boundaries. The work of drawing pillars which have been standing this length of time, is not only very dangerous but often more expensive mining than ordinary room coal. With mechanical mining a section or panel that ordinarily would last two or three years by hand methods of mining would be worked out in three or four months with machines, and the pillar work is a great deal safer on account of having stood only a short while, the roof is in much better condition for drawing pillars, and the coal, for the same reason, has not deteriorated and will turn out more and a better grade of lump than would be the case if pillars were allowed to stand for a year or two. This of course applies to the character of coal mined in the northern Wyoming field.

There is only one disadvantage encountered with mechanical pillar drawing. We have yet to discover a mechanical loader that is really safe for pillar work, or I should say as safe as hand work for the men, on account of the noise made by the machine. I was asked one day by a visitor at our mine how we detected roof breaks or noises that usually serve as a warning in pillar work. I told him we couldn't, we just simply trust in God and keep on loading coal. We have had some very close calls, but as yet have never lost a man nor seriously injured one in two years of exclusive mechanical mining. The close calls referred to were occasioned soon after mechanical loaders were installed and on drawing pillars that had been standing, some of them, two or three years.

It takes a year or two after mechanical loaders are installed in a large mine to clean up and get away from old rooms and pillars that were in process of mining when the installation was made. When this has been accomplished and the work is more concentrated, as I have already stated above, the rooms advance very rapidly. Pillar work is started much earlier and as a result the roof conditions are much better.

### CARE AND MAINTENANCE OF LOADING MACHINES

Care and maintenance of loaders must be considered a most important detail, if it is expected to operate a mechanical mine to the uttermost efficiency. Skilled mechanics are very essential and at least one man is required at each mine who is an expert in electrical and acetylene welding. With a well equipped machine shop and the right kind of men, many repairs can be made on the job that otherwise might tie up a loader for a day or two if the property is located in a remote section of the country. You may have in stock $10,000 or $12,000 worth of spare parts, but occasionally some part that was least expected, will fail. A complete overhauling of each loader every year is very essential. All loading machines are, on account of the many functions they have to perform, made up of many moving parts, and although the workmanship and material may be the best that can be obtained, the service they are subjected to in a coal mine under all kinds of conditions is very severe; and a complete dismantling and inspection of every bearing and gear is necessary to accurately determine their condition. If a thorough overhauling is given each machine every year during the dull season, many delays from machine failures will be prevented when production is most essential. If this is done, and the cost of the work added to the annual maintenance cost, it will be found that the additional tonnage loaded by the more continuous daily operating time given through the prevention of minor repairs during the shift, will show a much lower total maintenance cost than if each repair was made at the time it occurred.

### SHOOTING COAL FOR MECHANICAL LOADING

This is the most difficult problem we have encountered in mechanical loading and is largely due to nature of the coal in the Sheridan field and, no doubt, this difficulty is met with in other fields. To shoot a room 25 to 30 feet wide with one round of shots, in coal with no parting and no defined cleavage, without shearing or snubbing, and set it down in good shape for loading with any kind of a loading device, while making a good percentage of (*Continued on page* 462)

* General Superintendent, Sheridan-Wyoming Coal Co., Sheridan, Wyo.

# LOADING BY MECHANICAL METHODS EXCLUSIVELY

*High Operating Efficiency Required—Room And Pillar Method Best—Even With Bad Roof And Bottom Complete Recovery Is Usual—Booster Hopper Used To Equalize Car Movement—Coal Must Be Broken Loosely—Uniform Voltage Essential*

*By* DAVID INGLE*

A FEW years ago, even since we began having these very interesting gatherings here in Cincinnati, which is very recently indeed, it would not have been such an easy matter, to report confidently, and with assurance, on loading coal at the face by mechanical methods, exclusively.

Today, we all take such a suggestion as a matter of course; we are doing it, and this paper is merely intended as a report on how one mine does it, and expects to continue doing it, unless discussion at this meeting, or elsewhere, shows us how we can make changes to do it better.

For this thing of mechanical loading is still so new, that better ways of doing it are constantly bobbing up. Methods that seemed good a few months back, go into the discard promptly, as better ones are suggested.

To load coal at the face, all mechanically, first we must have a dependable machine, one that doesn't break down, one that will keep plugging at it, day in and day out, with only a reasonable amount of care and attention. Only a year or so ago, we thought we were doing fairly well, if the loading machine was in commission say 75 percent of the time. Today, if we lose as much as 7 percent of the time on account of the difficulties of the machine itself, we aren't doing so well.

Unless we are working a continuous face, longwall, or a modified form of it, or unless we are using a machine which can both undercut and load the coal, or unless we use a machine that will mine the coal off of the solid, without shooting at all, unless we use one of these types of machine, we must have a machine that not only is dependable for loading, but it must also be able to move quickly from one working place to another. Time lost in moving from place to place must be reduced to a minimum, because when the machine is moving, production stops.

Most of us here who are using mechanical loaders, when we started using them, tried to avoid this time lost in moving, by trying to get away from the old-established room and pillar system. The advantages of a long face looked so great, and so attractive. We tried it, and we gave it up, and came back to the old room and pillar, at least for the present.

*We* came back to it, and now we are working rooms 24 ft. wide, 33-ft. centers, 200 ft. deep, trying to make the best of it, not entirely convinced that there isn't a better way, but succeeding fairly well at this one.

These rooms, after shooting, contain an average of about 30 tons of coal per shot, and we load out from 5 to 7 of them with one machine per shift. This means from 150 to 210 tons per machine crew per day. Our roof isn't good, our bottom is soft, sometimes wet and soft. The coal varies in thickness from 5½ to 6 ft. Under these conditions, the machine loads out all of the coal, except occasionally a little that is blown back into the props, in shooting.

It takes an average of from 5 to 10 minutes to move the machine from one working place to another. This figures out a minimum of 25 minutes, and a maximum of 70 minutes per day, lost in moving from place to place. The minimum isn't bad, but the maximum should, and can, be cut down. The machine moves around, out over the tracks, from place to place, with no short cuts through the break-throughs, as the bad roof must be timbered too closely to permit that needed advantage. The machine travels on the rails, on its caterpillar treads, which are set to track gauge, 42 in.

The pit cars hold 2¼ tons, machine loaded. They are handled in five car trips, by gathering locomotives. The five cars are backed into the working place, the rear one loaded, all pulled out, the loaded car shunted back on the entry, then the four cars are backed in, the fourth car loaded, all pulled out, the loaded car shunted back, and so forth. When the five cars are all loaded, the locomotive takes them to the nearest parting, brings back five empties, and the process repeated. The gather locomotives are either cable reel type, or storage battery. We use both, because we have them, but we prefer the battery type, as we have no serious grades.

In connection with some of our loading machines, we use auxiliary loaders, which we call boosters. The object of this booster machine, is to give the loader something to put coal in while the pit cars are being changed loads for empties, thus attempting to afford continuous operation of the loader. We have been rather successful in this, and the loaders assisted by the booster have shown about 25 percent more production per day, as compared to the loaders delivering direct to the car. The additional labor required is one man, to operate the booster.

This booster is simply a hopper-shaped car, on a self-propelling truck, the hopper holding about 3 tons. The bottom of the hopper consists of a flight conveyor, which runs along the bottom, up an incline, and extending out over the pit car far enough to drop coal into the front end of it. The flight conveyor is similar to the one on the rear conveyor of the loader, except that it is wider, and runs faster. Consequently it can load a car very quickly—we do it in 15 seconds. The coal is loaded from the loader into the booster, and from the booster into the car, simultaneously at times, but whereas it may take a minimum of 40 seconds to load the booster, with the loader, as stated above, it only takes about 15 seconds to load the car from the booster. We think it is a very nice arrangement, and are rather pleased with ourselves for working it out.

Of course, the whole secret of mechanical loading is to keep the loading machine busy. If we could only do that all of the time we could makes lots of money. So it gets to be a game, trying to see how busy we can keep it. Like all games, it is disappointing and vexatious at times, when things don't go right.

Things will be going along fine, looks like a big day, when suddenly the loading machine backs over its power cable. There is a flash, the room is filled with smoke, the machine dies, and 10 or 15 minutes' fast work are put in splicing the cable. The machine starts up, the coal begins to move, the cars are loaded, the locomotive rushes out with its loads, starts back with its empty trip, and splits a switch, piling the cars all over the neighborhood. All hands set to work, and after another 30 minutes of profanity and perspiration, things start moving again, but the chance for a record loading for that crew on that day are gone, unless things go without a hitch the rest of the shift.

Loading coal with machines is a gregarious pastime. It is very different from the old-established method of producing coal, where each miner, or each miner and his buddy are off by themselves in their own working place, working as much, or as little, as they please. Receiving a periodic visit from the mule driver, a daily visit from the pit boss, loading a car, sitting down to eat a piece of pie. Loading another car. Sitting down again to smoke awhile. Perhaps if the turn is a little slow, he gets chilly, decides he has done enough, picks up his bucket and his coat, and calls it a day. Machine loading isn't like that. But, because it is gregarious, because it is group work, time passes faster, and the fact that he has to work the full day doesn't go so hard as it might otherwise. Our fellows seem to take to it with real good will.

To get back, we must keep the machine busy, and we are making quite a bit of progress in doing it. Never was there a place where real efficiency would count more and yield greater returns. We are not efficient yet, but we are infinitely more so than we were three or four years ago.

Some of the things we must do to get that efficiency are:

First, the machine itself must be dependable. We have said that, and it has become so.

Second, the coal it is to load must be broken down enough so there won't be any tight shots. We still lose much loading time, through failure to have this done right. The principal trouble in our mine is that the coal in no two working places shoots exactly alike. I suspect that maybe our mine is not peculiar in that respect. But a charge of explosive that will lay the coal down nicely, in good lump condition, in one room doesn't do the same thing in the next one. The same amount of explosive may shatter the coal into bug dust in the next room; or, on the other hand, it may barely crack it and leave a tight shot. We still have quite a bit to learn about this, after more than four years of trying to learn to do it just right.

* President, Ayrshire Coal Co., Oakland City, Ind.

Third, if all the coal were broken down just right, probably the machines would be able to load it so fast that we would have a transportation jam and be unable to keep the coal away from the machines as fast as they loaded it. But here again we are learning better track, easier turns, heavier rail sections—these things are coming to pass gradually.

Fourth, maybe we haven't progressed as far as some of our friends have, but we still have power troubles. Low voltage is a serious handicap, but absolutely a preventable one. We have suffered much from it. Now we are moving our motor generators back into the mine, right in the middle of the work section, and as the work advances the generators are going to advance right along with it. Owing to the great concentration demanded, many power consuming units in a restricted space, much more copper in transmission lines is essential.

There are lots of minor troubles, I have merely touched on some of the major ones.

After all, most of the mines that are loading coal mechanically today, are mines that were in operation before loading machines were realities, and ours is one of them.

Usually these mines are trying to get along with the equipment they already had. Their mine cars are too small. Their rail sections are much too light. Their power equipment, and their transmission lines are woefully inadequate.

Most of them were developed to a degree, and in a manner, anything but suited to concentrated mechanical production. And concentration is one of the great advantages of machine loading. Concentrated work means better supervision, and great efficiency is impossible without close supervision, and lots of it.

Few of the older mines had adequate preparation facilities in their tipples for the handling of the large amounts of impurities that are necessarily loaded out with machines.

All of us, of course, have had to build up slowly, and painfully, our employe organizations from raw material, and we have usually had to overcome more or less hostility from the men in the ranks and sometimes from officials in the organization itself in doing this building. Such an organization could not be bought, or hired; it doesn't exist today, outside of the plants where it has been built and is functioning.

Last year it was stated here that 90 percent of the game of mechanical loading is organization. That isn't far wrong, but, of course, there is the mine itself, its physical conditions, to consider, and also the kind of equipment available. If we assume that the organizer won't start the job unless he has just the right kind of a mine in all respects, and just the ideal equipment, then we may say that organization is 100 percent, and not be very far wrong.

To finish up: Our experience has been gained in the mine we have been describing. We are using eight loading machines and employing 150 men, all told. We are producing, of late, about 1,350 tons per shift. Nine tons per man employed. For four years we have been shooting at a production of 10 tons per man, and we are gaining on it.

When we get it we will raise the mark a little and start again.

## DRY CLEANING AT THE BERWIND WHITE OPERATIONS

(*Continued from page* 430)

you are inclined to erroneously assume that whether it be wet washing or dry cleaning, all that is necessary to do is to build the plant, and that it will immediately start operation without further difficulties. Nothing could be further from the facts. We have our troubles.

"Mr. Enzian mentioned some of the difficulties that we encountered in the construction of the Berwind plant. Unfortunately for the builders of dry cleaning plants, the art of dry cleaning of coal developed too rapidly. The principle of the art of dry cleaning met with success over night. The result was that the builders of these plants had handed to them contracts for processes, or for plants, which had not been fully developed.

"Within the last two years (and in this I speak of all of the builders of dry cleaning plants) we have had 15 or 20 plants forced on us, ranging in capacity from 50 tons per hour up to 400 tons per hour. When you have plant capacities of that kind, handling coal through 2½-in. size, of which the fine coal makes up a very large percentage, you have a problem not only in coal cleaning but also in dust collecting that is a very big and serious one. The Berwind plant is of 540-ton tipple capacity and 400 tons per hour cleaner capacity.

"When we built our first dry cleaning plant in West Virginia in the Pocahontas field, handling the fine Pocahontas slack and dust, we thought we had the hardest problem in dust collecting that could be found, not only in the matter of collection of dust from the tables but also the dust-laden air outside of the plant. But we fooled ourselves! We found one at Windber that was dustier. When one considers the large number of tables required for cleaning 400 tons per hour and also the large number of screens for screening that capacity, it is at once apparent that we had a large problem to solve.

"We have met with success in the handling of the dust at Berwind. Some of our earlier dry cleaning plants were not very presentable and the dust question was a very serious obstacle in the sale of dry cleaning plants. We have had some of our prospective clients stick their noses inside of the door and then "beat it." There was too much dust there for them to even consider the installation of a dry cleaning plant. They had the fear of an explosion. I can say, however, that in so far as that is concerned we work with open lights in our dry cleaning plants. The air is clarified to such an extent that I have seen a lot of tipples much dustier than dry cleaning plants.

"The problem of dust collecting within the plant itself is simply a problem of collecting the air that comes from the tables and the screens. The problem of the dust-laden air without the plant is a serious one. The job is to collect the air from the screens, tables, and other dust-making machinery and put it into the dust collectors, clarifying the air so that no appreciable amount of dust floats away from the plant. That is a very big problem and we have made very good progress in solving it.

"The figures that Mr. Enzian gave you of 180,000 cu. ft. of air in the three collectors are very large. They are correct for that plant. That is large when you take into consideration the volume of air that we are blowing and collecting. We are reducing this very materially and within a very short time we hope this air-collection problem, which is a great power consumer in dust collecting plants, will be reduced so that the horsepower consumption will be small, and quite necessarily, the cost of installation will be very low.

"The one point that I would like to stress in Mr. Enzian's paper, and this is true whether you build a dry cleaner or a wet washing plant, is to be sure to make a thorough investigation of your problem before you go into it. We have proven the wisdom of this by making tests of the coals for dry cleaning purposes for all plants built by us. In all cases we very closely approached, and in some cases have bettered, the results obtained at our testing plant. All of the tests have been made on carload samples of coal. It is very important to do this for two reasons; not only from the ash or sulphur analysis standpoint, but to get the proper percent of the various sizes that go to make up the slack coal. The screening of the coal in a dry cleaning plant is very important; if you can make a test of more than one car of coal it is a good check on your problem. It is also much easier for the engineer and designer of the plant, for the reason that one carload of coal might not be a representative sample of your entire mine or give an exact condition of the percentages of fine sizes. This happened to be one of the difficulties we experienced not only in the Berwind plant but in all others. We design the screens to handle a certain size product at a capacity determined by test plant results, then find it necessary to adjust the screens, after they are installed, to accommodate the percentages of sizes as they occur in the actual plant operation.

"The plant horsepower mentioned in Mr. Enzian's paper might seem large as compared to other processes; but when you take into consideration that you have no drying facilities to provide for after the coal is cleaned, no drainage facilities, no pumping facilities of any kind, which must all go to make up the total plant cost, the total horsepower consumption is not great for that plant capacity. I believe the horsepower given also included the tipple horsepower which should not be charged to the dry cleaning plant. If I am wrong I desire to be corrected.

"The plant cost as given is correct for the Berwind plant, but you, gentlemen, will undoubtedly desire to know what the approximate cost of a dry cleaning plant to suit your own requirements would be. The cost varies, but we can assume that it will be from about $500 per ton per hour capacity up to $1,000 per ton per hour capacity, depending on the plant you build and the coal you desire to clean. The cost of operation, taking into consideration all charges, but exclusive of a charge to cover loss of refuse, runs between 10 and 13 cents per ton.

"The one point I want to stress is, be sure to make a thorough analysis and a carload test of your coal before you contemplate either a wet or a dry process."

## IS MECHANICAL MINING DEPENDENT UPON ROOF CONTROL

(*Continued from page* 449)

"Supports can be devised strong enough to support the roof, but the control of the roof does not depend on the strength of that support. It depends on the area of an artificial support introduced after you have excavated the coal. The area that a 6-in., or an 8-in. or a 10-in. steel solid column can support, may theoretically, take care of all the roof weight calculated above the seam, but, it will not support the strata for the simple reason that it will be pushed through the bottom or the roof and the roof will come down anyhow.

"Consequently, to control the roof properly you have to have an adequate area of support. In other words if you take out a cut 5 ft. wide and 100 or 200 ft. long or 500 ft. long, you have to replace that coal by a supporting area sufficient to let that roof gradually down while you are advancing. That is the principle of packwall used in the old country.

"If you want to eliminate packwalls and you want to control roof by sheer strength of a certain support that will not be sufficient. Such a thing as breaking the roof 15 or 20 or more feet from the face is wrong mining. I am not now talking about a 100 or 200-ft. face, but I mean on a face 1,000, 2,000 or 3,000 ft. long. It is impossible there. It was never accomplished."

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*MR. R. Y. WILLIAMS, Weston Dodson & Co., Inc., Pottsville, Pa.:*

"There is a certain line of thought that has been carried out today that some few of us are trying to get away from, and that is that a longwall to be successful has to go rapidly, and that you can hold the roof without a compressible packwall back of it; that if you use jacks the roof pressure will shove the jacks either through the roof or through the floor. Those are the thoughts.

"At Indianola from the discussion today I found that they lost the face and it was some time before they discovered the conveyor. Now, if that roof broke from the coal vein to the surface, and came down straight they never would have seen the conveyor. So there must have been some open space in there along the face. That must have been true and if the roof will break off short on the coal, and you put something 6 or 8 or 10 ft. back of the roof as strong as the coal, you can break the pop there.

"At one of our places we have been breaking it for 2 years or more, 18 ft. back from the face. If we advance the face to 6 ft. a day and move up the jacks 6 ft. a day, the roof breaks off short immediately back of the jacks. At one time we approached a clay vein that was practically parallel with the face. We had a 3-ft. cutter-bar and we put that on the machine in place of our ordinary 5-ft. cutter-bar. We therefore moved our jacks only 3 ft. We got exactly the same 3-ft. break that we had gotten previously when we moved up 5 ft.

"If you calculate the pressure on our jacks from the floor to the surface, each one is holding 10,000 tons. Figuring the cover that we have, that is true. We also know that all of our 6-in. jacks, together would not hold 10,000 tons or anywhere near that. Consequently, we must be working along the right road in thinking that the pressure is less than that.

"What we think we are doing is this: Our roof is a stratified series; you might almost liken it to bricks with vertical cleavages in them as well. If the roof were to break immediately on the coal, the break would be a diagonal, staggered line, possibly averaging about 45 degrees out from the face. That would be the case up as far as we could see it. Where it goes after that we have merely our theory to guide us. The roof itself is the thing that is holding our long face open. All we are doing with our jacks is steadying the bottom layers of that to prevent their moving at all and to present immediately back of the jacks a completely open space where the roof is bound to break and relieve the weight from our face.

"We have the one place where that has worked 2 years or more and we have never failed to clean the face and move our jacks in a day. We can stop our face for 10 days and on the 11th day start the face without spending one dollar for extra labor as the conditions have remained unchanged during the 10 days.

"I don't know whether we are on the right track or not. I hope that in another year we may have different mines under three different roofs with three different coal beds with three different distances to the surface to be able to describe."

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## SCRAPER LOADERS APPLIED TO MODIFIED LONGWALL FACES

(*Continued from page* 456)

*MR. C. R. STAHL, E. E. White Coal Co., Stotesbury, W. Va.*, led the discussion of Mr. Blakeslee's paper, saying:

"Any discussion of long face work involves a comparison of the long face with the room and pillar system of mining, also a comparison of extensive and intensive systems of mining.

"The room and pillar system is more flexible than any other and can be used with any conditions of top, grades, or drainage. When, however, mines become large, supervision becomes more expensive and inefficient, and the costs of mining coal under 4 ft. in thickness are apt to mount very rapidly.

"Mechanical mining to be efficient, must be done with less labor than hand mining and must be done with more concentration. The concentration of work not only allows of more intensive supervision but by its nature tends to greater safety in mining. On the other hand, it requires a higher grade of supervision than the check system of hand loading and very close attention to details.

"The principal problem in long face working lies in top control. Very few people are skillful enough to produce a top fall at will, yet most of the plans as yet developed call for this very thing, and with a square face at that. It appears that under certain roofs, the placing of heavy unyielding jacks on say two foot centers will cause the roof to break off instead of riding over on the solid coal which is what happens when round timber or timber cribs are used. My experience is that the cheapest top support is coal. A cubic yard of coal may be worth a quarter or half a dollar and will hold up as much top as $50 worth of timber or iron jacks. Very few people attain 100 percent recovery, and it is possible to control the top by leaving in 10 or 15 percent of the coal in predetermined places.

"We find it is better to carry an angle face not too wide between supports. Thus, the top weights will come on the points of the angles thus relieving the pressure on the working faces. It is at the points of the angles that the coal should be left in. If this is done, the work can be done so that falls are made across the points of the angles, or by the use of intermediate cribs the roof can be so supported that it will not break at all. In places where there is any danger from spontaneous combustion it would be best to leave in a minimum of coal and break the top.

"The scraper loader is one of the machines being used to work low coal on long faces. It has some advantages over other machines and like the others, has certain definite limitations. The advantages are:

"1. Moderate first cost.

"2. Practically eliminates hand loading.

"3. Simple in operation, requiring but few repairs.

"4. No machinery need be covered up by an occasional loss of face.

"The limitations are:

"1. Space required for scoop limits application of the scraper loader to good top.

"2. Bottom must be sound and fairly smooth.

"3. Coal must be clean unless the preparation plant is very complete.

"4. It has the defect common to most mechanical means of loading coal in that the coal is usually shot pretty hard to make it easy to load.

"If you have clean coal from 30 in. to 4 ft., have good top and bottom, and do not require a maximum of lumpy coal, the scraper loader will do you good service provided you are willing to supply the close attention to detail which any concentrated system requires."

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## MINING IN WYOMING BY MECHANICAL LOADING EXCLUSIVELY

(*Continued from page* 459)

lump, is really the work of an expert, and the expert will often fail to do the job to the satisfaction of the loading crew. This, of course, leads to overshooting in order to make sure of bringing all the coal down.

Shearing is one way to overcome this difficulty, but even this increases the amount of small coal and also adds considerably to the machinery investment.

Regardless of the method adopted, the problem is hard to solve by the regulation of powder and placing the shots; but progress is being made by training drillers and shotfirers to systematically prepare faces by methods found to give the best results by actual experience.

I have only related a few of the important matters pertaining to mechanical loading. These are not theories or ideas gleaned from articles on the subject but just common sense and cold facts that we have learned from actual experience; and, although we have been fairly successful in mining by mechanical loading exclusively, we are still learning, and have a great deal more to learn.

However, there is no question but that mechanical loading is here to stay, as we have proved it to our own satisfaction.

# ENTRY DRIVING WITH MECHANICAL LOADERS

***Entry Driving Under Peculiarly Adverse Conditions Accomplished At Four Times Normal Speed—Mechanical Loading Yields Large Output With Good Wages, Fair Profit And Reasonable Price To Consumer***

*By* O. S. NEWTON*

THE mines of The Sunday Creek Coal Company are located in Athens, Hocking and Perry Counties in southern Ohio, in what is known as the Hocking and Sunday Creek Districts. The seams of coal ordinarily mined in this district are the No. 7 seam, which averages about 4 ft. in thickness and the No. 6 seam which varies from 4 ft. to 8 ft. in thickness. This No. 6 seam is a consistent, uniform seam of coal, and with the exception of known and well defined faults, is persistent over the entire territory.

In the village of Corning, Ohio, The Sunday Creek Coal Company have a mine known as mine No. 8, working in the No. 6 seam. This mine has been in operation for about 40 years. During this period the mine was worked in what is known locally as the Congo Basin. In this basin the coal seam is from 8 to 12 ft. in thickness, the coal consisting of the regular 6-ft. seam with from 3 to 4 ft. top coal. Early in the year 1925 it became evident, on account of the exhaustion of this coal, that in order to maintain an economical tonnage at this mine and develop sufficient working territory so that the mine might have a long, future life, it would be necessary to drive through what is known locally as the "Jumbo Fault," and develop a large acreage of known coal lying east of Corning. This coal east of the "Jumbo Fault," having been first carefully drilled, developed the fact that there was, at least, a mile of deficient entry to drive before the coal would be found normal in thickness and quality. The problem then became one of driving deficient entry as rapidly and cheaply as possible.

During the year 1925 a 20-ft. tunnel, 1,046 feet long, was driven through the "Jumbo Fault." After the tunnel was completed, a tile brattice wall was built 8 ft. from one rib for ventilation. A single wide tunnel was driven for the reason that it was very much cheaper than to drive two tunnels with the necessary breakthroughs. This tunnel was driven with an air compressor and air drills. Dynamite was used for shooting. The ventilation of the entry was carried out by means of a 12-in. Jeffrey blower fan with 12-in. canvas tubing. This tunnel was completed early in 1926. After having given the question of rapid entry driving in deficient coal careful study, it was decided to use a Jeffrey 43-A Shortwaloader to drive this deficient entry. In connection with this Shortwaloader was purchased 300 ft. of Jeffrey 47-A Sectional Conveyors, and one 50-A Jeffrey Transfer Conveyor. This equipment was installed on April 16, 1926, and has been in operation steadily from that time until April 1, 1927.

*Figure 1*

*Figure 2*

Sketch No. 4 shows the entries developed during this period.

The coal in the deficient entry varies from a minimum of 32 in. in height to a maximum of 78 in., the average being about 72 in. As the height of the Shortwaloader is 35½ in., it was necessary to take down top to that height as the entry advanced. The Shortwaloader is what its name implies—a unique combination of a short wall mining machine and a coal loader. This machine has three cutter bars. The bottom bar undercuts in the same manner as a short wall machine. During the time that the machine is undercutting the two top bars are swung back along the right side of the machine where they are entirely out of the way. After the cut has been made the coal is shot down, the machine is then brought back to the right side of the entry, and the three cutter bars are sumped into the coal which has been shot down.

Figure 1 shows the machine loading coal moving across the face.

* General Manager, The Sunday Creek Coal Company, Columbus, Ohio.

The bits in the three chains drag the coal back to a conveyor which starts at the pivoting point of the cutter bars and carries the coal across the top of the machine onto a second swinging conveyor. This swinging conveyor, which may be held and operated in any position horizontally, in turn discharges the coal into a sectional conveyor which carries the coal back to the transfer conveyor. This, in its turn, discharges the coal into the mine car.

There have been several plans developed for hauling the coal away from the loading machines or conveyors. In some cases, the empty cars are shoved through a breakthrough, and the delivery end of the 47-A conveyor discharges directly into the mine car. Owing to the fact, however, that the mine car in this case is not placed at right angles to the end of the conveyor, it is difficult to load the cars to their full capacity. Inasmuch as no cribbing is done on cars loaded mechanically, and the capacity of a car, therefore, reduced, it seems to us to be better practice to load from the sectional conveyor onto the 50-A transfer conveyor, which should be, at all times, at right angles to the mine car.

Figure 2 shows this arrangement in actual practice.

In order that there might be no delay in loading out the coal from one crossing, sufficient track was laid past the transfer conveyor, toward the face, to hold cars enough to load out one crossing.

Sketch No. 1 attached shows the arrangement as used.

Another reason, in our case, why we use this method of delivering coal into the mine cars, was that, in order to make rapid advancement, we drove the parallel entry by hand, and if we were shoving our empty cars through the breakthroughs, this would not have been possible.

The coal was hauled from the transfer conveyor with a small 2½-ton trolley locomotive. This worked out best for us for the reason that the locomotive had ample time to pull out a trip of coal containing a full crossing, deliver it to the main line motor switch and return enough empty cars for the next crossing. The use of a locomotive in this case does not make it as necessary to move the gathering switches as often as would be the case if a hoist or horse was used for hauling.

We secured permission from the state inspector of mines to drive breakthroughs of 300-ft. centers in driving our main entry. This, of course, reduced very much the cost of driving breakthroughs, as well as reducing the loss of air due to leaks.

The ventilation of our main entries, as they were developed, was by means of a Jeffrey 20-in. blower fan connected to a 12-in. Y, and from this Y to 12-in. canvas tubes leading to the head of each entry. A temporary brattice is placed across the intake entry at the same location. This is in order that there may be no short circuiting of the used or bad air. When we first started this system of ventilation, a 12-in. fan with tubing was used on each entry, but as this coal produced some gas, we were fearful that if one of the fans were down for some time, a pocket of gas would accumulate which might be blown out along the entry when the fan was started. For this reason we changed the fan and used a Y connection, so that if

**COMPARATIVE COST DRIVING DEFICIENT ENTRY**

**(a)—By Shortwaloader**
**(b)—By Hand and Breast Machine**

| | Total No. Shifts (Includes Moving) | Average Per Shift Ft. | Total Distance Driven Ft. | Width Entry Ft. | Ave. Height Ft. | Total Cu. Ft. | Total Labor Cost | Total Tons * | Total Cost Repair Parts | Cost Per Cu. Ft. | Power Cost Per Ton | Total cost per ton labor, repair parts and power |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | $1,375 | Cents .0022 | Cents | |
| (a) | 544 | 13.18 | 7174 | 14 | 6 | 602,616 | $27,200 | 24,398 | | .0451 | .06 | $1.1724 |
| (b) | 460 | 5.6 | 2576 | 14 | 6 | 216,384 | 12,006 | 8,760 | | .0554 | .02 | 1.32 |
| | | | Saving in favor of Shortwaloader | | | | | | | .0081 | | .147 |

In addition to this saving, entries are developed about three times as rapidly as by hand work.

* Based on 85 lbs. per cu. ft., .2352 cents cu. ft. per ton.

**COMPARATIVE COST DRIVING ENTRY IN NORMAL SIX FEET COAL BASED ON 30 DAY EXPERIMENT**

| | Ave. per shift Ft. | Width entry Ft. | Ave. height Ft. | Total labor cost | Tons per shift | Repairs estimate | Power cost per ton | Total cost |
|---|---|---|---|---|---|---|---|---|
| (a) | 24 | 14 | 6 | $50.00 | 80 | $.01 | $.06 | $.6954 |
| | | | | Cost tonnage rates | | | | |
| (b) | 5.6 | 14 | 6 | .9290 Entry loading | 20 | .... | .02 | 1.1780 |
| | | | | .1790 Entry cutting | | | | |
| | | | | .05 Entry hauling | | | | |
| | | | | 1.1580 | | | | |
| | | | | Savings in favor of Shortwaloader | | | | .4826 |

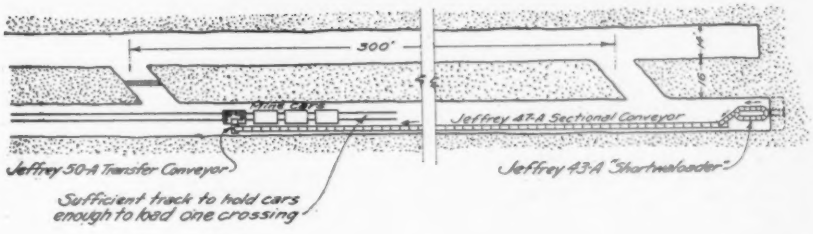
In addition to these savings entries were developed at least four times as fast as by hand work.
The power required to operate this equipment is:

1—50 H. P. Motor on 43-A Entry Driver
1—20 H. P. Motor on 47-A Sectional Conveyor
1—¾ H. P. Motor on 50-A Transfer Conveyor
1—30 H. P. 2½ Ton Locomotive

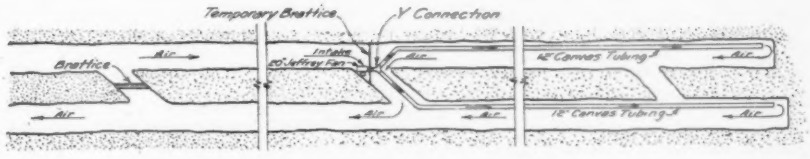
Total—100¾ H. P.

**LIST OF REPAIR PARTS PURCHASED FOR JEFFREY SHORTWALOADER AND CONVEYORS**

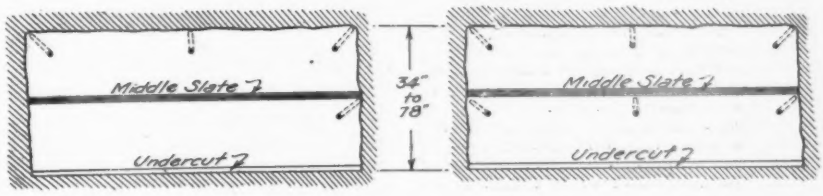
| 1926 | | | | | Cost price | |
|---|---|---|---|---|---|---|
| 4-30 | 1 | | 104405 | Lock for leading bars | $40.90 | |
| 11-17 | 1 | | 104405 | Lock for leading bars | 28.73 | Still in stock |
| 9-11 | 6 | | 99628 | Short up or down links | 18.78 | |
| | 6 | | 99630 | Long up or down links | 18.78 | |
| | 6 | | 99629 | Int. up or down links | 18.78 | |
| | 6 | | 102905 | Special links | 39.18 | |
| | 6 | | 99631 | Special long up or down links | 18.78 | |
| | 6 | | 103617 | Long special bits | 7.08 | |
| | 6 | | 103616 | Short special bits | 7.08 | |
| | 6 | | 104393 | Medium special bits | 7.08 | |
| | 6 | | 95133 | Center links | 18.78 | |
| | 24 | | 85225 | Connecting links | 14.64 | |
| | 6 | | 95137 | Special long up or down links | 18.78 | |
| | 6 | | 95136 | Long up or down links | 18.78 | |
| | 6 | | 95134 | Long intermediate links | 18.78 | |
| 9-24 | 1 | ¾ H. P. | | Robbins and Myers back geared motor for 50-A Transfer Conveyor | 121.94 | |
| 12-24 | 1 | | 86965 | Cable eyes | 1.12 | |
| | 1 | | 80768 | Wedge for cable eye | .15 | |
| 12-11 | 1 | | 101708 | Armature pinion | 12.78 | |
| 12-18 | 1 | | 104087 | Bushing | 5.00 | Still in stock |
| 1927 | | | | | | |
| 1- 8 | 5 | Lbs. | 98760 | ½ x 1 C. S. Rivets | .40 | |
| | 10 | | 103135 | Conveyor flights | 20.71 | |
| | 2 | | 84515 | Circular wearing strips | 7.75 | |
| 1-11 | 2 | | 86965 | Cable eyes | 2.24 | |
| | 2 | | 80768 | Wedge for cable eyes | .30 | |
| 1-17 | 12 | | 102572 | Conveyor flights | 54.69 | |
| 1-20 | 6 | | 98760 | ½ x 1 C. S. rivets | .68 | Still in stock |
| 1-26 | 2 | | 84508 | Wearing strips | 12.81 | Still in stock |
| | 2 | | 84509 | Wearing strips | 12.81 | Still in stock |
| 1-29 | 12 | | 102685 | Connecting links | 16.45 | |
| 2- 4 | 2 | | 102980 | Wearing strips | 6.12 | Still in stock |
| | 2 | | 102981 | Wearing strips | 6.12 | Still in stock |
| | 2 | | 104553 | Wearing strips | 4.12 | Still in stock |
| | 2 | | 104554 | Wearing strips | 4.12 | Still in stock |
| | 2 | | 86352 | Circular strips | 6.02 | |
| 2-12 | 1 | | 103999 | 21-tooth jaw clutch | 26.76 | |
| 2-14 | 2 | | 104151 | Cable anchors | 3.50 | |
| | 1 | | 84514 | Circular liners | 14.55 | Still in stock |
| 2-11 | 1 | | 104120 | Loading bar support | 191.09 | |
| | 2 | | 84515 | Circular liners | 7.50 | Still in stock |
| 3- 2 | 1 | | 104308 | Cutter bar complete | 137.39 | Still in stock |
| 3- 4 | 1 | | 103852 | 36-tooth sprocket | 18.17 | Still in stock |
| 3-15 | 1 | | 10522 | Trans. conveyor chain | 3.35 | Still in stock |
| 3-16 | 1 | | 103272 | 15-tooth sprocket | 6.12 | Still in stock |
| 3-17 | 3 | | 98112 | Special long down links | 9.42 | |
| | 3 | | 98111 | Special long up links | 9.42 | |
| | 3 | | 98110 | Long down links | 9.42 | |
| | 3 | | 98109 | Long up links | 9.42 | |
| | 12 | | 11770 | Flat head cap screws | 6.00 | |
| | 2,666 | | | ½ x 1 x 4½ Strt. Pick point bits | 119.97 | |
| | 500 | | | ¼ x 1 x 4½ Chisel point bits | 20.00 | |
| | 1,140 | | Feet | 5/8" special plow steel cable | 225.48 | |
| | | | | Total | $1,375.00 | |


300'
Drive Cable
Jeffrey 47-A Sectional Conveyor
Jeffrey 50-A Transfer Conveyor
Jeffrey 43-A "Shortwaloader"
Sufficient track to hold cars enough to load one crossing

SKETCH NO. 1



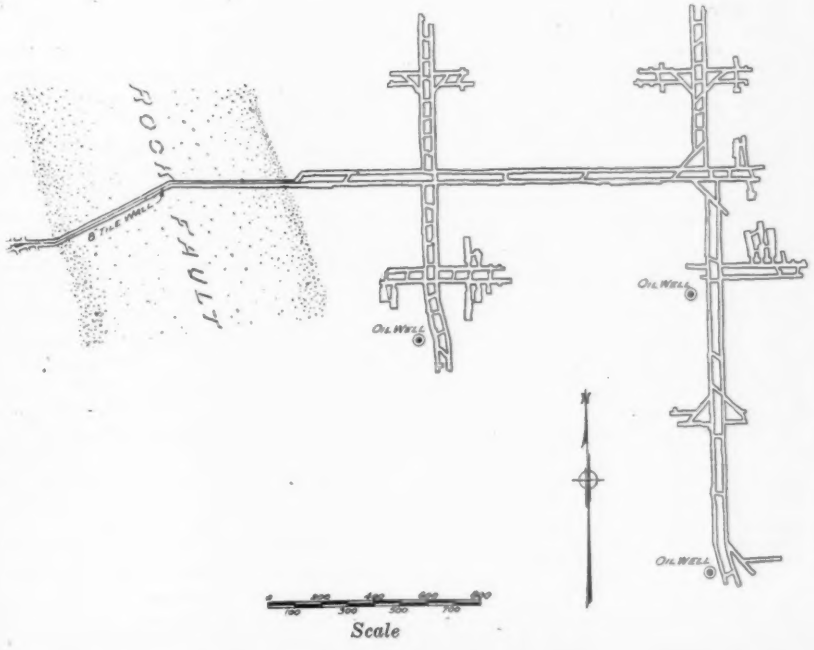

SKETCH NO 2




DRILLING WHEN ENTIRE SEAM WAS LOADED.

DRILLING WHEN BOTTOM COAL WAS SHOT FIRST AND LOADED OUT, THEN THE TOP WHICH WAS NOT MARKETABLE WAS SHOT DOWN AND LOADED AS GOB.

SKETCH NO. 3




SKETCH NO. 4

either entry was ventilated they would both be ventilated. Sketch No. 2 shows the arrangement of this ventilating system.

The operating crew on this installation consists of two machinemen, at $10 each; two drillers and shooters, at $7.50 each; one conveyor man, at $7.50; and one motorman, at $7.50; giving us a total cost of $50 per day for labor. In order to save as much time as possible in preparing this coal on the tipple, the drillers, shooters and the conveyor man move back along the sectional conveyor and pick the coal while the machine is loading a crossing. This undoubtedly slowed up production somewhat.

As the bottom coal in this seam has sulphur balls, the cutting in the greater part of this entry has been very hard. The number of sets of bits required per crossing ran from one to seven sets. This seriously affected the production possible with this type machine. While the machine is making the undercut, being operated by one machine man and one helper, the two drillers follow up back of the cutter bar and do the drilling for the next cut. For this a Jeffrey 5-A electric drill was used. During this time the conveyor man adds a section to the conveyor, the motorman hauls out the loaded trip and returns with sufficient empties to load the next crossing. When the cut has been completed, the machine is backed out from under the coal so that the shot will not cover the machine. The canvas tubing, which is carried on a wire along the left hand rib, is now slipped back far enough so that it will not be torn down by the flying particles of blasted coal. The fan is not stopped during this operation, and the crew are able to return after a period of about three minutes to their loading place.

The bottom coal in our seam is ordinarily good and marketable even in deficient entries, while the top coal may be so laminated with slate and bone coal as to be worthless. When this condition was met, three holes were drilled just below the middle slate, which ordinarily is about 40 in. above the fire clay. This coal is then shot down and loaded with the machine as merchantable coal. Three holes were then drilled at the roof and the top coal shot down and loaded out with the machine as gob.

Where the entire seam was merchantable coal, with the exception of the normal impurities, and could be loaded with the Shortwaloader, it was necessary to use four holes and to shoot four charges in each crossing—one at the left-hand rib, one in the center of the cut, and two in the right-hand rib, one of these two near the top and one just below the middle slate. Our experience indicates that for successful loading with this machine, the right-hand rib must be thoroughly broken and shot down, as otherwise there is a tendency for the coal to bridge from the rib. If this occurs, the coal does not fall until the loading bars have moved some considerable distance across the face, and then when it falls it is behind the loading bars and must be shoveled over the cutter to the gathering side of the machine.

Sketch No. 3 shows our method of drilling and shooting in the two cases mentioned above.

Due to the tough and springy nature of the impurities in the top coal, we have been forced to dynamite for all the shooting while driving these deficient entries, using for this purpose one and

one-half sticks per hole of Grasselli No. 9 Monobel.

On account of the irregular conditions encountered in this work, having at some points only sufficient coal to cut in, and other points a full seam of merchantable coal, it is practically impossible for me to give you a fair cost per ton for loading coal with a Jeffrey entry driver. I have, however, compared the cost of driving deficient entry, which possibly will run 50 percent coal and 50 percent unmerchantable gob on a cubic feet basis. We are able to make this comparison intelligently for the reason that the parallel entry to the entry in which the entry driver has been working has been continuously driven by hand using day labor for this purpose at $8.70 per day, which was our scale for driving deficient entry by the day. Based on experience, we find that three men can cut, shoot and load out one crossing per eight hours in this type of entry. These comparative costs work out as shown in chart on page 2.

The total cost of all repair parts purchased for this equipment was $1,375.00, or .0022 cent per cu. ft. This seems rather high, but when you consider that this machine was handling slate, rock, water, etc., the cost seems reasonable. I am attaching an exact list of all repair parts purchased. This may be of some value to those of you who may wish to know just what parts are necessary to keep on hand.

During the last few weeks' operation this machine, in pockets of good normal coal with good roof and bottom and under fair conditions, has been able to average 4 crossings, or 24 feet per shift, or 8 hours, producing in this time 20 tons of coal and 1 car (2½ tons) of gob per crossing, or 80 tons of merchantable coal per shift. Using $50 per day as the labor cost, gives us a labor cost on the mine car of .6254 cent per ton of merchantable coal. Considering the fact that this is all entry coal, this cost appears to be reasonable, especially when a three-shift operation, which we have maintained for the past several days, drives from 60 to 74 feet of entry per day.

The comparative cost of loading normal coal by loaders at tonnage rates, and by Shortwaloader is as shown in chart on page 2.

The power cost per ton handled will average .06 cent per ton based on a power cost of 2 cents per kilowatt.

You appreciate that in order to operate this type of equipment to capacity, and to prevent heating and burn-outs of armatures and fields, and burning of controllers, that good power lines of the proper size and adequate rail bonding must be maintained.

In all fairness to this equipment, I wish to call your attention to the fact that this equipment has been operating under the most adverse conditions, with bad top, hard cutting, soft fire clay bottoms, and in very wet places, but in spite of these obstacles we feel that the Jeffrey Shortwaloader is a well designed and practical loading machine, and under normal conditions, properly applied, will cut and load coal either in rooms or entries, at a very reasonable cost. The 47-A Sectional Conveyor has given practically no trouble. It is quick and easy to extend and shows no apparent signs of wear after 544 shifts, or 4,352 hours of use. The 50-A Transfer Conveyor is the only part of this equipment that might be criticised. We do not believe that this conveyor is reliable enough to be depended upon to handle the output of the 43-A machine and the 47-A conveyor, as it is of very light construction, and has some rather delicate parts such as small sprockets, chains, etc. The motor is backgeared and located under the discharge end of the 47-A conveyor where all of the drippings of water or fire clay drop through upon the motor. We feel this conveyor should be redesigned, using a more reliable motor and built so that in case of motor trouble any spare motor around the mine may be used to maintain continuous operation.

In conclusion, we are very well satisfied with our brief experience in driving entries with a mechanical loader. The cost statements mentioned above show clearly and conclusively that this class of work can be carried out considerably cheaper and a great deal faster than by hand work. We believe that the mechanical loading of coal will eventually solve our labor problem, as it will permit the operation of large capacity coal mines with a very much less number of men than at present, that it will allow the machine operator good wages, will secure for the operator a fair profit, and furnish our country's coal to the consumer at a reasonable price. We believe, however, that the greatest problem in connection with mechanical loading of coal, is that of developing a satisfactory method of cleaning coal and disposing of refuse at a reasonable cost.

We expect to continue our experiments along this line and will be very glad to exchange memos of experience with any other operator who may be carrying out the same kind of development work.

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Following the presentation of Mr. Newton's paper ***MR. EDWARD GRAFF,*** *Mining Engineer of the New River Co., Macdonald, W. Va.*, led the discussion, saying as follows:

"I can say that the company I am with has been experimenting for the past 3 or 4 years with the Shortwaloader. We have felt that sometimes we were very successful. Then we would feel again that we had made an absolute failure of it.

"In the first place it doesn't make any difference what kind of piece of equipment you put in the mine, I don't care how good it is, nor do I care how the management in general, feel about it, but if you do not get every man in that mine sold on that particular machine you may as well not spend any money for the squipment.

"We have 5 of the 43-A Shortwaloaders. We put one of those machines in a 12-ft. entry and practically the first week of its operation we got out 35 cuts, almost 6 cuts per shift in 8 hours. We had very good conditions. The coal was 4 ft. or slightly more in height, roof fairly good. But in the seam of coal which we are working in West Virginia, we have very unusual roof conditions. We may drive along for 100 ft. and have ideal conditions. The next 100 ft. may be the worst you will find anywhere. Therefore, when we would drive along with this shortwaloader we would run into some bad conditions. In doing our best it would hustle us to get 2 or 3 cuts per shift when handling the slate.

"That, of course, demoralized the crew that had been making such good progress with the machine. If the operation of the machine is not followed up very closely the men who are working on it will be disinterested and the first thing you know your machine work will be a failure. On the whole I believe the machine has given us good development. It has not always been cheaper than hand loading, owing to our conditions, but I feel with the development that we have gotten from the machine we are better off than we would have been without the machines.

"In working the machine I feel that if you had 6 ft. of coal, good top, there should be no question but what the men should get out at least 6 cuts per shift in 8 hours.

"In reference to the shooting of the coal, if you leave that up to the machine operator, we all know that he is going to make it as easy as possible for himself and for the machine. He is going to shoot hard enough so that he feels that that machine will load there without trouble. Nevertheless, I do think that any machine, regardless of what kind, that loads the coal mechanically is going to produce more fines than if it was loaded by hand and shot properly. You can increase the lump to a certain extent with the Shortwaloader by proper shooting of the coal. But if the man who is looking after that shooting is not there continually and he leaves it up to the other man we all well know what he will do."

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## LIGHT OILS FROM UTAH COAL

A study of the composition of light oils from low-temperature carbonization of Utah coal has been conducted by chemists of the Bureau of Mines and Carnegie Institute of Technology. This investigation was undertaken because of the need of information on the composition of low-temperature oils and tars in their evaluation by buyer and seller, by producer and user, and others. The investigation was one coordinated with a study of the use of superheated steam as an internal-heating medium in the production of smokeless fuel and with a study of the gases produced during the carbonization and their variation with temperature. The coal used was from Mesa Verde bed in Utah and was a non-coking coal.

The oil from the gas produced when Mesa Verde coal was heated at a maximum temperature of about 725° C. by means of superheated steam was examined as to its composition. The amount of oil recovered was about 7 c. c. per kilogram of coal, 1.7 gallons per ton.

The results of this study are given in Bulletin 31, Mining and Metallurgical Investigations, by R. L. Brown, organic chemist, U. S. Bureau of Mines, and R. B. Cooper, research fellow, Carnegie Institute of Technology. Copies of the bulletin may be obtained from Carnegie Institute of Technology, Pittsburgh, Pa., at a price of 15 cents.

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The largest strip mine in southern Illinois is being planned by the Mississippi Coal Corp. The company is negotiating with the Solar Coal Co. for the possession of property totaling 400 acres near Freeburg. The company already has options on 1,670 acres.

# MECHANICAL LOADING IN UTAH COAL

***Ratio Of Width Of Room And Pillars To Overburden Determined—Control Of Shooting Essential—Decreased Haulage Costs Through Increased Output—Saving In Seven And A Half Months Single Shift Operation Paid For Installation***

*By* GEO. A. SCHULTZ,*

IT is a well known fact that most of us attend meetings of this sort to be entertained and instructed.

It is not the purpose of this paper to either entertain or instruct, but merely to give you the experience of the Liberty Fuel Company, Carbon County, Utah, in its attempt to load coal mechanically during the past year.

While this company has saved money over hand loading methods from the first day's operation of its loading machines, there were many changes made in personnel, track layouts, etc., before the arrangements finally adopted and in use now were arrived at, and it is our hope that these experiences, both good and bad, will simplify the task of others, who may be contemplating similar installations.

Before attempting mechanical loading of any sort, a representative of the company visited five different operations in the West, where there were as many different methods in use. It was decided beforehand, however, that some machine which would readily fit into the old room and pillar method was necessary, because of the nature of the overburden at the company's property.

It was decided that the Goodman Hydro-Electric power shovel was the machine which would most successfully meet the conditions at the property and one of these machines was put into operation May 10, 1926, and another December 10, 1926.

These shovels were put at work in coal between 7½ and 9 ft. in thickness, with an exceptionally good roof and floor. At first the rooms were driven uphill on the pitch of the seam as is the practice in this district for hand loading. The pitch of the seam varies from 7 to 10 percent. The rooms were driven 28 ft. wide and with single track, with a short parting or pass-by in each room and extension rails were used. This was a serious mistake for, while the shovel would load on this grade without any trouble, it was soon found impossible to change cars rapidly enough with animal haulage. Rooms were then driven on the strike of the seam with double tracks in them. These tracks were put on the low side of the room close together, leaving a space of about 12 ft. wide on the upper side of the room for the travel way for the power shovel. The track nearest the low rib is kept within 12 ft. of the face and the other track about a car length shorter or 20 ft. from the face. This arrangement allows the shovels to be kept busy constantly as far as car supply is concerned and on account of one track being shorter than the other, cars can be changed without interfering in any way with the operations of the shovel and the entire face can be cleaned up without any extension of track during the operation.

The coal is very hard to cut, two to three sets of bits being used to cut one room. The cutting is very important as the shovels require a fairly smooth bottom, free from steps.

* General Superintendent, Liberty Fuel Co., Latuda, Utah.

It was found that, with less than 500 ft. of overburden, 28-ft. rooms and 24-ft. pillars were sufficient, and with 500 ft. to 1,000 ft. of overburden, 26-ft. rooms and 30-ft. pillars were about right. With the double track in rooms, two cuts or 12 ft. are loaded out of each side of a breakthrough with no change in tracks. The remaining cut after being shot down is pushed through by the shovel until within reach of the track and then loaded into cars. This is done in either direction depending on which way the shovel is traveling. This operation consumes about 20 minutes and delays loading operations that long, but we find it less expensive than to lay tracks in the breakthroughs.

At first the actual loading crew consisted of an operator, a car trimmer and a face man. However, it was found that in shooting the coal to obtain the same percentage of lump sizes with the shovels, as in hand loading, there were too many extremely large lumps for the shovel to handle and it was necessary to add another face man, whose duties were to break up these large lumps ahead of the shovel and to load the last or clean-up car in each room. The coal is singularly free from cleavage planes or slips and breaks in very large lumps when properly shot.

One of the features of this method of operation is that the shooting of the coal is directly under the company's control and can be varied to suit the vagaries of the market with no harmful after effects. We all know that once a miner is given permission to overshoot the coal, it is almost impossible to ever again get him to produce a maximum of lump coal.

The success of the shovel depends to a great extent on the way the coal is shot down for it. It is difficult to obtain the same percentage of lump sizes when an entire face is shot down at once, as compared with shooting out the center one day and the ribs the next as is done by hand miners in this district. In our coal we find that 5 holes across the top of the room inclined upward and fired with delay detonators, and 4 holes about 3 ft. above the floor inclined downward and fired with instantaneous detonators give the best results. These 9 holes are loaded with 22 sticks or 11 pounds of permissible powder, the amount per hole varying with its location. The result is 55 tons of coal shot down or 5 tons per pound of powder, which is considered very good in this hard coal.

It was found impossible to keep sufficient development work ahead of the shovels with the ordinary 300-ft. rooms commonly used in hand mining methods, as the Utah laws permit no shooting while men are in the mine. In order to overcome this difficulty, rooms are made 1,000 ft. long, and a cutoff put in at 500 ft. to avoid too much track material being tied up at once.

We find that with our exceptionally good roof conditions it is possible for the shovels to do their own development, by driving haulage ways 22 ft. wide, which is the minimum width the shovels will work in.

Because of the pitch of the seam and the high price of hardwood in the West, it is more to our advantage to make a removable section of track opposite the breakthroughs where the shovels travel, rather than to use plank crossings. This is successful with small cars and animal haulage, but I doubt if it would be so with locomotive haulage and large mine cars.

We find that the only real objectionable features in connection with loading by these shovels are: more spillage of coal along the haulage ways, due to hasty topping of cars; cars which held 4,300 pounds hand loaded dropped to an average of 3,100 pounds when loaded by the shovels; complaints from customers, who accepted the enormous lumps loaded by the shovels as a novelty at first, but soon decided there was too much work involved in breaking them; and that it is impracticable to try to clean the coal at the face.

I want to say here that we have had no increased cost for cleaning the coal at the tipple since using the power shovels. This is due to the fact that our coal is normally very free from impurities and also to the fact that non-union miners never would clean the coal at the face, as well as union miners.

It would appear that there would be a decided increase in haulage costs, because of the smaller capacity of the shovel loaded cars, but this is not the case, because of the fact that the concentration of workings made necessary by the shovels, and the rivalry between haulage crews and the shovel crews in trying to avoid delays on their end of the game, speed up the former, so that their output per man per shift is really considerably in excess of the men serving hand loaders.

I want to mention, here, that due to the practical elimination of the deading labor caused by hand loading, everyone connected with the operation of the shovels goes at his work with a speed and cheerfulness that is seldom seen around a coal mine, and that while the daily earnings of the men are less because they are all on company wages, their annual earnings are equal to or greater than the hand miners, because these men producing cheaper coal are given steadier working time.

I believe that we are getting a lower daily tonnage per shovel with one or two exceptions, than any similar installations in the country. I also believe our repair costs are higher. This is because of the very small mine cars and because the coal is so hard and blocky that it is more like handling rock than coal.

Because of the nature of the coal seam there is always a lot of standing coal in a place and much semi-loose coal hanging on the face. To work this coal out with the face men delays the shovel too long, so the shovel is used to tear it down, and naturally loses considerable loading time while doing this. A

lot of this trouble is caused by the kerf not being thoroughly cleaned of bug-dust, before the place is shot. The use of water on the cutter bar of the mining machine makes it almost impossible to clean the kerf on the low side of the room as the wet bug-dust packs in the kerf almost like cement. Our high cost of repairs on the shovels is caused almost entirely by using them to tear the hanging coal from the face, and to set aside huge lumps of coal to be broken up by the faceman while the shovel continues to load loose coal.

In spite of these facts 10½ months' operation of one shovel and 4½ months' operation of the other, or an average of 7½ months' each, have made a saving over hand loading methods formerly in use sufficient to pay for both shovels.

I ask you, what other installation in or around a coal mine has paid for itself so quickly?

In times past, given the same conditions, the difference between the keenest and most energetic management and the mediocre management would result in a saving of less than 10 cents per ton, by the former.

I am sure that if our coal were used entirely for steam purposes or coke where the lump percentage was of no consequence, and we could shoot harder it would be possible to increase the output per shovel 50 tons daily, with all other conditions remaining the same.

These machines have been worked single shift. Had they been double-shifted each shovel would have paid for itself in less than four months and made the company a profit of $25,000 per shovel during the remaining eight months of the year.

The shovels have averaged 180 tons for one and 190 tons for the other per 8-hour shift since the first day of their installation. The two have loaded 67,000 tons of coal in the period mentioned.

These figures are valuable, because they do not represent guesswork, or the prophecy of a machinery salesman, but actually what has been accomplished.

The figures on savings accomplished may seem unbelievable to some of you, but one other similar installation in the Utah field, with better operating conditions, and using this same type power shovel has so far exceeded them as to make this installation seem inefficient.

There are many fairly intangible savings by this method of loading, due to the concentration of workings. A saving, though small, might be mentioned and that is 40 percent on compensation insurance due to the smaller number of men for a given tonnage.

It is hard, for a number of reasons, to compare the safety features of hand loading with that of loading with these shovels. However, when four men with the aid of the power shovel load as much coal as sixteen hand loaders, it will be seen that the number of men exposed to hazard for a given tonnage will be 75 percent less. This should certainly result in added safety in advance work at least. There is no doubting the fact that the noise of the shovels will to a certain extent drown out the warning sounds given by timber and working roof, in the pillar work, but the speed of the extraction will help to reduce this danger.

While a 33 percent reduction from the Jacksonville scale would not make mechanical loading quite so necessary or attractive, there would still be such a large saving that no one with suitable conditions can afford to overlook it.

Suitable conditions for the use of one of these power shovels would mean a coal seam over 6 ft. in height which is fairly clean and has a hard bottom and a top which will stand without timbering back of the face (although I understand there are operations where timbering is kept close to the face, timbers being moved when they are in the way of the operation), and which is on not over a 15 percent grade; where there is someone in the company's organization, vitally interested and with power to make changes necessary to give the shovels a fair chance to make good; other factors which will help toward success are large capacity low-built mine cars, good tracks and a constant supply of empty cars.

The old-time foreman looks at mechanical loading with an indifference that is easily understood. When he had his operations scattered all over the map and the mine heavily over-manned, it was no cause for worry if operations in one section of the mine were temporarily stopped through any cause, for he knew the other sections could take care of all the extra empties they could get and it would not make any difference in the day's output or his costs because it was only contract miners that suffered. With mechanical loading it is a different story. All the men are company men and if for any reason a unit is stopped, dollars soon vanish into thin air. The management wants to know what is the matter as it is greatly interested in the results of one of these units, where the individual contract miner, since the war, has never been an object of great interest to anyone but himself. For this reason, and the fact that it is very easy to lay a finger on the trouble with concentrated operations, the mine foreman and everyone else in any way connected with mechanical loading must be on his toes or someone else will soon be showing him how to avoid delays.

In the long run, it is your help which finally makes or breaks you. Bear this in mind, when you select the men to have charge of your loading operations. See that they have a knowledge of the possibilities in this work and that they are given a chance to make it a success.

Including the original excavation and all the great slides there was a total of 240,000,000 cubic yards of material excavated at the Panama Canal, over a period of ten years. This was accomplished with many then modern steam shovels and dredges and is still considered one of the greatest engineering feats of all time. When we stop to think that more than twice this enormous bulk of material is moved by hand every year in the coal mines of the United States, under far more cramped and ill-suited conditions, it appears that here is the one industry more than any other, that has unlimited possibilities in applying labor-saving machinery.

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***MR. S. W. FARNHAM**, Goodman Manufacturing Co., Chicago, Ill.*, discussed Mr. Schultz' paper, in which he said:

"In commenting on Mr. Schultz' paper I find it difficult to add anything because he has covered the subject so completely and so well.

"Anyone who has not seen the Castlegate or Utah fields can scarcely appreciate the hardness of the lumps nor the way in which they are there locked in the face after mining and shooting, where the shooting is carried on in such a way as to obtain a maximum percent of merchantable lump coal. The problem that faces a loading machine in most of the mines where they have been installed is the problem, I think, of loading what we might term "over-shot" coal—too heavily shot.

"Mr. Schultz has told you that he has maintained the same percentage of lump by carefully regulating the shooting and has been obliged under his conditions, in order to maintain the merchantable quality of his coal, to have some of the larger lumps broken by hand prior to loading by the machine. The designers of the Goodman power shovel worked along original lines in building a loader. They adopted the hydraulic principle to an underground shovel and have allowed a pressure power for the shovel of something like 6 tons. It would be impossible to get this pressure easily were it not for the fact that this shovel is equipped with a central hydraulic jack which is placed quickly against the roof, locking the machine between the roof and the floor so that it can successfully withstand the thrusts from the shovel.

"This is of particular advantage where there are grades or inclinations or slippery floors. I might say the machine is caterpillar mounted so that it does not interfere with the track transportation as was mentioned yesterday in connection with shearing. The shovel goes through the break from room to room.

"The shovel has a lifting power, when the scoop is close to the shovel, of 5 tons and when the scoop is out at its greatest distance it has a lifting power of about 3 tons. We attempted to work out somewhat the same ideas that are embodied in the surface steam shovel, namely, to get something that would be powerful enough to get into the mass of coal without hesitation and pick up a suitable sized load and deliver it by means of its ejector plate directly into the car without passing over conveyors or other accessory apparatus.

"I think the shovel in the Utah field is working under quite difficult conditions as to high pressures and that it has been shown it has stood up to the work quite well. I might add that that same machine is being used to handle very heavy lumps of salt in some of the eastern mines and has shown ability to handle extremely large pieces of coal. We feel in listening to these discussions that there is a big field for a shovel that does not require excessive shooting. We all know, however, that powder will make any loading machine work more easily and increase its capacity. I will not take your time to go into the full details of this device except to say that we have been developing a machine along the lines to take care of requirements not only for the producer of steam coal but also of domestic lump."

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The Utah Coal Operators' Association is being organized with headquarters in Salt Lake City, and it is expected that all of the Utah operators will be represented in the organization. The work of the association will be carried on along regular industrial lines. Temporary chairman and secretary have been appointed and another meeting is scheduled for the near future.

# MAINTENANCE OF MECHANICAL EQUIPMENT

***Mechanical Loading The Youngest Child In The Mining Family—Mechanics Always Kept Available In Immediate Area Where Machines Are In Operation—Constant Inspection Maintained—Maintenance Costs Similar To Those With Any Mining Equipment***

*By* I. N. BAYLESS *

THE mining game is one of the oldest, if not the oldest industry now in operation. The Egyptians left records of mining in 1400 B. C. Mechanical means of extracting the valuables from the earth have been developed very slowly until only the last few years. The latest development has been the use of machinery for loading and is a new game to most of the industry. It is true some mechanical loading devices have been on the market for years but very few men have had any experience in operating, maintaining and repairing these machines. Hence, within the old game of mining we now have a very interesting and fascinating new game of loading mechanically.

As is always the case of a new machine there is and must be much experimenting. Many of the machines on the market today are still in the experimental stage. We have had much experience in the experimental stage of the various kinds and types of loading machines, both as a purchaser and operator of loading machinery and providing proving ground for machines not ready for the market. We have done much experimenting on the machines while operating the equipment and obtaining results on an operating basis. The new machines have introduced many new engineering features to the mining game and made organizations and facilities inadequate that were formerly considered fully efficient.

Before installing mechanical loaders we visited as many operations as possible which were equipped with different makes of machines, we also talked to a number of operators that had tried loading machines and had discontinued their use. The consensus of opinion was that it was next to impossible to maintain the machines as there were very few old mining machine manufacturers that were building a loading machine or at least had perfected a machine at this time. Before starting mechanical loaders our underground mechanical equipment at the Kathleen Mine consisted of 30 mining machines, 21 locomotives and 7 electric pumps. While our underground shop was adequate for this machinery, to care for the additional equipment in mechanical loading we decided that it would be necessary to build an additional underground shop or enlarge the one in use (which was located near the main shaft bottom), and as our live work was approximately one mile from this shop we decided the additional shop should be placed as nearly as possible in the center of the section of the mine where we were installing loading machines. The mine was developed in all directions for a total capacity from five to six thousand tons per day.

Feeling, that with loading machines the working places required would be less than one-half the available places, we decided to install loading machines on the east side of the mine. We then decided to build the additional repair shop one mile east of the main shaft and as nearly as possible the center of territories that were to be worked by loading machines. This shop was to be 18 ft. wide and 40 ft. long with additional space for shop equipment, storage of machines and store rooms for supplies. The shop was constructed with pit underneath and equipped with a 10-ton traveling crane, drill press, grinding stand, portable electric drills, an electric arc welder together with all kinds of mechanic's tools. The next problem was to secure mechanics to man the shop and repair loading machines.

At the start, none of our men had any experience with maintaining any type of loading machine and the number of mechanics available for learning by actual experience was limited. The mine had to operate and the regular routine of maintenance work remained the same for the mechanics then in the shops. And, as there were no trained mechanics available, an effort was made to pick some young ambitious men who took an interest in what they were doing to make new mechanics. These were placed with the old men, and being in the shop, and on the job seeing, studying, and doing as much work as they could, they slowly but surely rounded into reliable mechanics.

Several plans have been tried and abandoned for maintaining the different units. We have endeavored to pick the good points from each plan and have worked out a system that is working now with very good success. Each pair of Goodman loading machines with the attending locomotives, cutting machines, drills, and shearing machines, have a mechanic stationed in the territory who takes care of all repair work except breakdowns that necessitates the machine going to the repair shop. This man not only repairs machines after they are down but watches the machines to prevent breakdowns and conditions repair parts to be used when needed. Joy machines which are some distance from the repair shop are maintained by the same plan. In one case a mechanic takes care of two Joys, two cutting machines, two drills and two locomotives. In another case one mechanic, in another extreme end of the mine, does the repair work for one Joy loading machine, two cutting machines, two locomotives and one electric drill. The two McKinlay machines have a mechanic for making repairs on the day shift. All mechanics stationed in the territory have a place to keep and condition minor repairs, and in addition to the regular kit of mechanic's tools he has special tools that are needed on the particular machines. He also makes frequent inspections and keeps all wire lines in repair. Machines that work within a reasonable distance of the shop have no mechanic on the territory. In addition to the men that are stationed in the territory there are four men and one foreman on the day shift and four men on the night shift in the loading machine repair shop, who are sent out on calls to the different machines (when no mechanic is on the territory), needing repairs and take care of repairs in the shop. In order to make complete and lasting repairs on a machine which must be taken out of service an extra Joy and an extra Goodman machine are available to use. This makes it possible to maintain the tonnage and also gives the repair men time to really do a first class overhauling job of the machine in the shop without pressure from the management responsible for tonnage. The mechanics in the shop when not otherwise engaged build up clutch units and conveyor drive units, for the joys and side and rear planetaries, and boom and scoop assemble for the Goodman. At the head of all of this work, as well as locomotive repairs and electric work underground, is the chief electrician.

We have added to the former mentioned underground equipment, 7 goodman hydraulic power shovels, with six operating and one kept as a spare; 11 Joy machines, 10 working and one kept as a spare; 2 McKinlay entry driving machines, 2 Jeffrey pit car loaders, 3 Sullivan shearing machines, 3 Joy shearing machines, 2 6-ton gathering locomotives and 18 electric drills, making approximately 100 percent additional underground equipment. We also enlarged the shop on the surface installing an additional turning lathe, a tool shaper and a 300-ton hydraulic press. We also have a Sullivan portable air compressor underground used to blow out all mechanical loaders once each week.

Along with efficient and speedy repairs are systematic and thorough inspections. Repairs are essential to get a machine back into service, but more essential is keeping the machine from being out of service. The only means of doing this is by inspections. We have developed a system of inspections to take care of the loading machines, which is not burdensome and is very effective both in knowing the condition of each piece of equipment at all times, and in knowing when and what repairs should be made. In addition to the daily and constant inspections made by the repair men and foreman, a detailed inspection report is made to the electrical engineer each week. There are three separate and distinct kinds of inspections made on the Joy machines. There is a motor inspection and brushes changed each two months on single shift machines and every month on double shift machines. This period, by the way, has been increased from one week to two months by eliminating defective parts. There is a partial inspection made by the foreman and any necessary repairs are reported to the loading machine superintendent at the end of each shift and taken care of by the night shift mechanics.

The detailed inspection reports, which are made by the mechanic and foreman, are read by the electrical engineer and recommendations for necessary repairs are made to the foreman and loading machine superintendent. If at any time these recommendations are not carried out, because of a major breakdown or

* General Superintendent, Union Colliery Co., Dowell, Ill.

**UNION COLLIERY COMPANY**
**KATHLEEN MINE**
**Dowell, Ill.**
**INSPECTION REPORT OF JOY LOADING MACHINE**

Machine No.....

Date.....

VOLTAGE AT WHICH MACHINE IS WORKING: Excellent—Good Fair—Bad

Condition of feeders if any to Joy territory.....
Condition of trolley insulators, and feeders in territory of Joy ..... Condition of bonding..... Condition of nips and cables on machine .....
Remarks: .....

INSPECTION OF MOTOR: Condition of motor wiring.....
Commutator..... Brushes and Brush Holders.....
Windings..... Bearings..... When was the machine last blown out with air.....
Remarks .....

INSPECTION OF CONTROLLER: Controller fingers.....
Controller contact segments.....Controller terminals ..... Condition of wiring to resistance.....
Condition of resistance.....
Remarks .....

GATHERING HEAD AND CONVEYORS: When were gathering discs lifted and inspected..... Condition of gathering head now as observed from operation.....
Condition of front conveyor flights.....Front conveyor chains..... Rear conveyor flights.....
Rear conveyor chains..... Does front conveyor clutch slip properly?..... Ampere..... Voltage.....
Remarks .....

CATERPILLAR CHAINS AND TRACK WHEELS: Condition and adjustment of caterpillar chain.....
Are brakes adjusted right?.....
Condition of track wheels and drive pin.....
Remarks .....

HYDRAULIC SYSTEM: What pressure is safety valve set for ..... Does rear conveyor swing properly ..... Does forward and reverse clutch work properly.....Note any leaking in the hydraulic cylinders..... Note any leaks in the hydraulic cylinders..... Does hydraulic pump work properly.....
Remarks: .....

LUBRICATION: What kind of lubricant in gear cases.....
In hydraulic system.....Are pressure lubricator and Alemite hoses operating properly..... Note oil level in differential transmission case.....
Pump drive case..... Front clutch case ..... Note any bearings not taking oil.....
How long have these bearings been clogged up.....
Remarks .....

GENERAL IMPRESSION OF MACHINES: .....

.....Inspector.

**UNION COLLIERY COMPANY**
**KATHLEEN MINE**
**Dowell, Ill.**
**Goodman Power Shovel Inspection Report**

Goodman No.....

Date.....

VOLTAGE AT WHICH MACHINE IS OPERATING. Excellent—Good Fair—Bad

Condition of feeders to territory.....
Condition of feeders and trolley inside of territory.....
Condition of return wires inside territory.....
Condition of cable to machine and nips at end of cable.....
Remarks .....

MOTOR INSPECTION: Winding..... Brushes..... Brush holders ..... Commutator..... Bearings ..... Condition of wiring to motor, resistance grids and controller..... Condition of resistance coil across field..... Oiling.....
Remarks .....

INSPECTED CONTROLLER: Date..... General Condition ..... Cleanliness..... Condition of contact fingers..... Loose connections.....
Burned tips on drum..... Condition of reversing drum..... Insulating Block.....
Insulating shields..... Leads into controller ..... Grids ..... Wiring from controller to grids.....
Remarks .....

GENERAL CONDITION OF VALVES, WATERPIPING AND WATER CIRCULATION: Operating valves.....
Roof jack valves..... Pump valves.....
Ejector valves..... Water pressure.....
Condition of water strainer..... Condition of pipe lines.....
Remarks .....

CONDITION OF REVOLVING PLANETARY: Bearings.....
If worn out can shims be taken out to eliminate loose play.....
Condition of pinion and gears..... Condition of friction bands..... condition of gears—rotating machine..... How many times has machine been blown out since last inspection report.....
Places not oiled.....
Remarks .....

CONDITION OF TRAVELING PLANETARY AND CATERPILLAR:
Condition of friction bands..... Gears.....
Operating levers and mechanism..... Drive chains..... Caterpillar..... Oiling .....
Remarks .....

CONDITION OF PUMP: Inspect—Cylinders.....
Pistons ..... Eccentrics..... Connecting rods..... Bearings..... Places not taking oil .....
Remarks .....

GENERAL: Bad places noted in main frame.....
In lifting arms..... In roof jack.....
Condition of shovel..... Of ejector.....
Ejector latch..... Rack rail.....
Brass Pinions..... ....., and operating handle.....
GENERAL REMARKS: .....

.....Inspector.

other hindrances tieing up the repair men, the machine that has not been attended to is reported in the next inspection and a special effort is made to get the machine fixed. The results obtained by these inspections can not be accurately determined but it can be assumed that many lost time breakdowns have been averted.

Some of the specific cases of trouble on Joy machines that have been found and in most cases corrected will be described as briefly as possible. Several drive chains and drive shafts were broken on the rear conveyor because there was no slip clutch in the driving unit. A cone clutch was put in this drive unit and the trouble corrected. Another trouble that soon showed up was the hard ground steel discs in the clutch units. They were too hard and brittle allowing the plates to break and soon causing the clutch to hang. The Joy Company obtained a tough Swedish steel that is very hard to break. Our clutches now last more than six months of hard work and before the life of the clutch was very uncertain, lasting in some cases less than one complete shift.

The soft graphite brushes on the Crocker Wheeler motor of the Joy machine proved a very uncertain factor. The brushes would split, wear down and often in less than one week the brush would be in such condition as to cause excessive sparking and heating of the commutator. We obtained a hard carbon brush from an exclusive brush manufacturer and now after several months of close watching, inspecting and changing brushes in these motors we find no ill effects from the hard brush and there has not been a worn out or broken brush of the new type taken out. We have not found the limit of wear on these type of brushes but they should last from six months to a year and the soft brushes were not dependable for one week.

Although loading machines have been cared for better than the average mining machinery they receive very hard usage and work under some extremely bad conditions. We have found, in some instances, roller bearings in the Joy machines unsatisfactory because of the rough and hard treatment and possibly lack of close care and attention. These bearings on the armature shaft, foot shaft and front conveyor shaft are being replaced by S. K. F. double self aligning ball bearings as fast as the roller bearings have to be taken out. Another trouble we had with the Joy machine was the tail pans were not built right. The conveyor flights would hang on the bottom edge of the front tail pan. These have been changed and now the tail pan does not circle the front conveyor shaft, being only a straight pan reaching to the top side of the drive shaft. These and numerous other changes have, and are being made. Weekly inspection report on Joy loading machines is shown in the accompanying chart.

The Goodman power shoveis we purchased were the first put in the coal mines, and we naturally found a number of parts that failed, such as main frames, shovel frames, caterpillar driving mecha- (*Continued on page* 472)

# PANEL DEVELOPMENT WITH MECHANICAL LOADERS FOR RETREATING METHOD

***Operating Crew Consists Of Eight Men—Development Work More Rapid Than Pillar Work—Reduced Efficiency On Pillars Amounts To Ten Percent In The Interest Of Safety—Complete Cycle Of Operation Standardized***

*By* JAY I. SNODERLY*

THE location of the mine, at which the following described panel development is being done, is about 15 miles south of Fairmont, W. Va.

The coal being worked is the Pittsburgh Seam. The seam is of hard structure, and averages approximately 8½ ft. in thickness. The bottom is hard fire clay. A strata of draw slate about 4 ft. thick lies directly over the coal and next to a sandstone strata. The draw slate will not remain in place without support, so it is necessary to leave 12 to 18 in. of coal as roof support while first mining is being done. A considerable portion of this "head coal" is recovered during retreat mining. The seam has well-defined cleavage lines, which are at right angles to each other.

The panels that are being developed are rectangular areas 2,000 ft. long by 1,145 ft. wide. Each panel is being pierced by three double butt entries. Each of these butt entries consists of an airway, driven 14 ft. wide, and a heading driven 10½ ft. wide and 35 ft. distance from and parallel to its airway with breakthroughs every 85 ft.

The distance between these butt entries, that are developing the panel, is 310 ft. from the center of one butt heading to the center of the next butt airway, or barrier line limit, as the case may be.

This distance naturally governs the length of the rooms, which are driven 14 ft. wide, with breakthroughs 14 ft. wide at 85 ft. intervals. Rooms are turned off the headings at 100-ft. centers, and are driven on the face of the coal at right angle to the butt entries. Driving sequence of the rooms will be explained later.

The limits of a panel are controlled by solid coal barriers left around the panel and of sufficient size to properly control the pillar line as it traverses the panel. One hundred and forty foot barriers are left to protect the main entries and 100 ft. barriers left along the butt entries. These barriers are recovered at the proper time.

The butt entry headings for the panel are turned off the main face entries by 63-ft. radius curves. This curve requires a No. 3 standard mine switch for the track and allows curvature that will permit reasonable speed in transportation.

The main face entries are driven parallel and on 35-ft. centers. Six entries are driven. These consist of 3 airways, 1 manway, 1 empty and 1 loaded track heading. The relative location of these headings may be visualized by assuming a position facing the direction the entries are driving, and going from right to left in the order named above. Breakthroughs at regular intervals of about 85 ft. are made except between the airways and the manway. This pillar is only broken at each butt entry. The airways carry the air on the intake. Two chutes are driven between the empty and loaded tracks at an angle to make proper side track facilities for the butt entry that is being approached. The airways are driven 14 ft. wide and the other entries are driven 10½ ft. wide.

Two loading machines are used in driving the face entries. The solid pillar between the airways and manway makes a natural separation of the territory, so one machine is kept working in the airways and one in the other three entries.

Two loading machines are used in driving butt entries and rooms.

One loading machine is kept in reserve as replacement for any of the machines that for any reason become unfit for work.

Hand loading is done along with loading machines at this mine, but the sections in which the different methods are employed are kept separate as much as possible.

The operating cycles of the machines are:

(1) Cutting of the coal with 7-ft. breast mining machines.

(2) Drilling the coal for shooting. The drilling is done by the cutters with drills attached to the cutting machines. Five holes are drilled. Two are placed about three ft. from the bottom of the seam and equidistant across the face. The other three are at the proper height to form the top.

(3) The shot firer loads all the holes with permissible explosive and electric caps. Approximately 14 sticks of explosives are used in each place. This varies according to width of the working face. At this time the shot firer fires the two bottom shots. These two shots are heavier than the others, so the coal will be well broken and easy for the machines to dig.

(4) The machine loads out the coal resulting from the two bottom shots. This coal, along with the dust made by the cutting machine, amounts to approximately seven tons, depending on width of places. Then the loading crew fires the three remaining shots and loads out the coal resulting therefrom, which amounts to about 14 tons from 10½ ft. places and 18 tons from 14 ft. places.

(5) Bottom scrapper then loads the bottom left by the cutting machines, and also smooths the ribs and top of the place if necessary. He usually loads 1½ tons from each place.

(6) The track man extends the track, then, in preparation for the next operating cycle. Temporary track is maintained by advancing with 20-lb. jumper rails on steel ties. If permanent track is required the temporary is taken up and replaced by 20-lb. steel on wooden ties in the butt entries, and 30-lb. steel in the main haulage entries. Track is 42-in. gage, and is kept in best possible condition to permit rapid transportation. The track system is manipulated so that a switch with sufficient track to accommodate 15 cars will be available within at least 250 feet of the working face of place where loading machine is working.

An operating crew for each loading machine consists of 2 cutters, 1 loader operator, 1 helper, 1 track man and shot firer combined, 1 bottom scrapper, 1 motorman, 1 snapper—total of 8 men.

Coal is transported from the loader in 2-ton cars hauled by a 6-ton motor equipped with gathering cable and reel. The motor brings sufficient empties from the side track to load out one place and holds to the rear of the trip while loading and shifting is being done.

Machines in the main face entries usually take two cuts from each of the three places during a shift, that being about the amount of coal that can be loaded during that time under ordinary conditions. The main face entry machines also drive the butt entries to the second room, from which point at the proper time, the butt entry machine will continue driving.

To simplify description of the panel development, the butt entries in the panel will assume Nos. 1, 2 and 3, and No. 1 will be the first entry of the panel broken off the main face entries, and Nos. 2 and 3 occupy the same relative position as indicated by their numbers. It will also be assumed that each of the butt entries have been driven to room No. 2 by the main face entry machine.

Since the pillar line always starts at the extreme limit of the last room on No. 3 butt, this is the main objective of the panel, and an effort is made to reach it quickly, because it controls the rate of production from the panel.

Rooms 1 and 2 are used as air returns and they are driven through at the same time as the butt entry is being advanced. If conditions demand, four rooms can be driven, along with the entries, but it is better to not do this, because they have to stand considerable time before being pillared. As stated elsewhere the ordinary shift loads out six places. Then since we have six "load outs" to be taken from four places, it is necessary to double on two of the four places. The doubling is always done on the butt entries to hasten its advance toward its limit. By the time rooms 1 and 2 are finished the entry has reached rooms 8 and 9. Then rooms 8 and 9 and the entries are driven similar to the described method of rooms 1 and 2. When rooms 8 and 9 are finished the entry has reached room 15. Rooms from 15 to 20 inclusive, will not have to stand very long before pillaring, and are driven in whatever way that will give the best tonnage results. When No. 3 entry has reached room 15, No. 2 entry and its rooms are started and worked in the same manner as described for No. 3 entry. When No. 2 entry reaches room 15 No. 1 entry is started to work.

By carrying (*Continued on page* 482)

* Chief Engineer, Bethlehem Coal Co., Fairmont, W. Va.

# MECHANICAL LOADING UNDER DRAW SLATE AND BAD ROOF

*Crew Of Eleven Men Per Loading Machine Unit—Machine Operates On Both Caterpillars And Wheels — Cutting On Tonnage Rate — Tonnage Per Man Doubled — Cost Of Production Lowered—Mine Accidents Decreased Seventy-five Percent*

By E. J. CHRISTY *

THE Wheeling Township Coal Mining Co. mine, situated in Harrison County, State of Ohio, with a daily capacity of 2,000 tons, operates in the No. 8 or Pittsburgh seam. The seam averages 4 ft. 8 in. in height with 1 in. to 3 in. bone parting near the center of the seam. The top is a draw slate 10 to 12 in. in thickness, above which is a stratified coal and slate roof for 6 to 10 ft. to the limestone.

The roof is tender and requires systematic timbering. The seam dips ½ of 1 percent to the southeast, with average cover of 100 ft.

Mine is worked on the room and pillar system, face entries driven on 1,050-ft. centers, room entries 440-ft. centers, rooms 200 ft. deep and 24 ft. wide, turned on 32-ft. centers.

In 1924 it was decided we should find some method of mechanical loading to get more tonnage per man and reduce our operating cost. After observation of many operations with various mechanical loaders, it was decided the Joy would be the best adapted to our condition for the experiment.

June 1, 1925, we started our first unit, one 5-B. U. Joy Loader, one cable reel gathering motor, one Shortwall machine, one electric drill and 24 3½-ton roller bearing steel mine cars.

A crew consists of 11 men: Operator and helper on Joy loader, motorman and trip rider, one driller, one shooter, one tracklayer, one timberman and three stone handlers; cutting is done on a tonnage rate.

We have confined our mechanical loading to room entries. Starting from the face entries the loading machine has to develop the territory the same as is done by the hand loading, in order to get a comparison of tonnage produced per man and cost per ton mined.

The loading machine in development on a pair of entries loads both coal and draw slate until the 150-ft. barrier is past and rooms turned to a width sufficient to start posting and gobing the draw slate, then the stone handlers are put on to handle the draw slate after coal has been loaded out. The loading machine and all work proceeds in a cycle, through eight rooms and the two entries, working rooms on one side only, and going in the solid, advancing until the end of the panel is reached, when retreating is started back on the other entry, room necks turned and switches laid as advancing was done.

### SYSTEM OF SHOOTING

Drill is carried on cutting machine and when the place is cut, four holes are drilled in the coal and three holes drilled in the draw slate. Hole No. 1 is placed just above the band in middle of the seam and center of the room, drilled to a depth of 3 to 4 ft. Hole No. 2 is directly over hole No. 1, only slanting to the top and full depth of the cut in the coal. Holes Nos. 3 and 4 are same as hole No. 2, placed, one near each rib.

Shot firer loads the holes with permissible explosive, firing No. 1 or snubbing shot first, then firing No. 2 shot, which is directly over No. 1, except to the back of the cut, allowing the two rib shots to stand charged.

The loading machine reaching this place loads out the coal that is shot down in the middle as quickly as possible, trying to get a specially designed steel stone jack under the draw slate before it falls. Loading machine is then placed in position for loading rib coal. The loading machine operator fires the rib shot with electric battery which rolls this coal out free, and when loading is completed to an extent possible to set the second stone jack, it is placed under the draw slate, with the same operation on the opposite rib. The helper shovels all loose coal to the center of the room around the first stone jack set. When the operator gets his machine back to the middle of the room in line with his track, the middle stone jack is removed, and one pass of the loading machine made to the face, picking up the loose coal placed their by the helper.

The Joy loader works on caterpillars while loading coal only, and proceeds from place to place on track wheels over 25 lb. iron 42-in. track gauge, using 12-ft. switches as standard.

### METHOD OF TIMBERING THE ROOF

The timberman goes into the working place when cutting machine has finished cutting, sets one row of posts on each side of the track with clearance for the loading machine or 7 ft. between road post, set 3 ft. apart, last post set within 6 ft. of face of coal. One row of gob posts are set on each side of the room between road post and the rib to within 3 ft. of the face, which places the posts near the face on a 45-degree angle in either direction from the track, allowing the loading machine to reach the rib, also giving maximum roof protection without any resetting of posts.

Of the total tonnage mined in 1925, .0971 percent loaded mechanically. Of the total tonnage mined in 1926, .0800 percent loaded mechanically.

January 1, 1927, the second unit was added and on March 31 of the total tonnage mined, .1440 percent was being mined mechanically.

By the introduction of mechanical loading tonnage per man has been doubled, cost per ton reduced and a decrease of 75 percent of mine accidents.

* Superintendent, Wheeling Township Coal Mining Co., Adena, Ohio.

## MAINTENANCE OF MECHANICAL EQUIPMENT

(*Continued from page* 470)

nisms, planetary drives, valves, oiling systems, etc., which in the majority of cases have and are being corrected by the Goodman Manufacturing Co., by making heavier castings out of better material and correcting the oiling system and installing better material in gears and gear shafts. The detailed inspection report made out each week is shown in the accompanying charts.

After considering the troubles enumerated you may think we have done nothing but find fault and patch machines. This is not true; in fact we have loaded coal. It has been to the interest of our company to obtain machines to fit our conditions and do the work that must be performed to load our coal. It is, and has been, the interest of the manufacturer to produce these machines and do their best to make the maintenance work on their respective machines as small and as easily made as possible. Generally they have aided in every way possible to make the machines a success under these particular conditions.

On the cost of maintenance of loading machines, suffice to say that after loading machines were installed, together with an increased number of locomotives, addition of shearing machines and drills, the cost of maintenance for both material and labor has increased 70 percent. That is, our maintenance cost on all underground machinery now, as compared to the maintenance of all underground machinery before loading machines were installed, has increased 70 percent. The number of men on maintenance work has been increased exactly 100 percent, but less work is being done on Sundays and idle shifts accounting for part of the 30 percent difference between the 70 and 100 percent increases.

In connection with reports on loading, shearing and undercutting equipment, we have an inspection of haulage locomotives made by competent mechanics at the noon hour and at the end of the shift. Minor repairs are made, if needed, during noon hour and major repairs are made at night. All gathering locomotives are inspected at night and repairs made so as not to delay the machine during the working shift.

Summarizing, after correcting designs and except for the newness to men and management, once an organization is worked out, and a system for doing the work is established and made effective by a capable and vigilant management, maintenance of loading machines is no more difficult than maintenance of the ordinary type of mining equipment in common use.

# SHAKING CONVEYORS ON PILLAR RECOVERY

*Difficulties Encountered In Trying To Control The Roof In Removing Pillars Outlined—Use Shaking Conveyors at Pittsburgh Terminal Properties—Practically All Coal In Pillars Extracted With Small Percentage Timber Loss*

By GEO. F. OSLER*

ANY information imparted on subjects of this sort is apt to be more or less of a negative nature, and its value often lies in the fact that it saves others from trying the same methods, or assists in discovering errors made in its execution.

In a period of over-production and keen competition, such as the bituminous coal industry is experiencing at this time, all operating officials are being pressed for lower production costs. Complaints on preparation, both as to impurities and size of coal, are common. The domestic trade all want large, lumpy coal.

Before mentioning mining methods I will try to show, for persons not familiar with roof conditions in the Pittsburgh or No. 8 seam, some of the difficulties encountered in trying to control the roof in removing pillars. With few exceptions, the Pittsburgh seam carries over it a layer of slate or stone, known locally by various names. It varies in thickness, but averages about 12 inches. Above this, roof coal is usually found; the thickness of this also varies. Above the roof coal and extending to the lime rock or sandstone is a strata which varies both as to thickness and material more than any part of the cover of the Pittsburgh seam. In some localities it consists of layers of slate and dirty coal; in others, what is known as soapstone extending from roof coal to the limestone; in others, slate and dirty coal; and, in some instances, immediately below the sandstone, is found a seam of coal known locally as "rooster" or "rider" coal. This coal is mined in some localities and is of good quality.

In making an examination of old maps of mines in the Pittsburgh seam, it is plainly seen that the operators were endeavoring to solve the roof problem, which was, to try to break it or to prevent it from breaking. This is still true; in western Pennsylvania all mining operations are carried on with an aim to breaking the roof. In Ohio and the Panhandle district of West Virginia mining operations are conducted with a view of supporting the roof; the opinion is that it is not possible to draw ribs.

In Pennsylvania the primary mining is done so as to leave ribs and pillars of sufficient strength to support the roof, yet make it possible to remove enough of this coal to make a major break in the roof and thereby relieve the weight on surrounding coal.

In Ohio the problem is to leave room ribs just large enough to support the roof temporarily and pillars along the entries of size sufficient to keep the squeezes which develop in room areas from riding over on entries. This is not always successful.

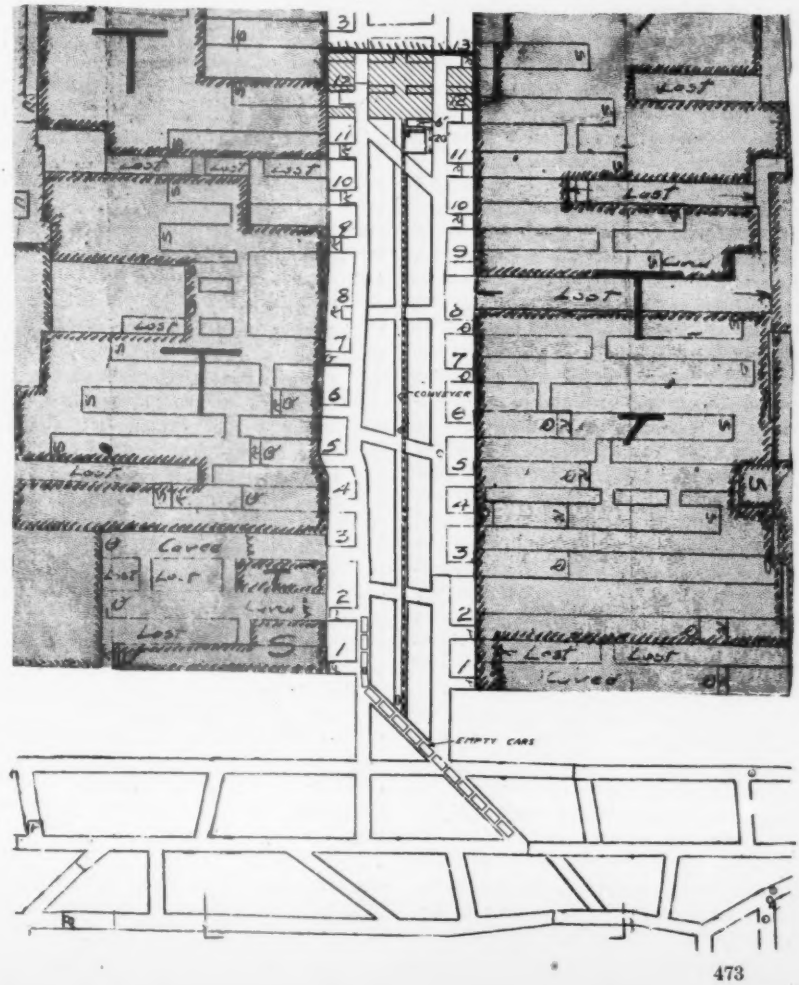
The Pittsburgh Terminal Coal Corporation have been using shaking conveyors at two mines—one tntirely in the extraction of pillars, and the other in rib-drawing or modified longwall mining.

Reference to the condition of the roof might seem foreign to the subject, but mining men familiar with conditions in the Pittsburgh district realize at once the difficulties of drawing pillars by any mechanical means after the entries have been standing for any length of time, as the roof usually falls, filling all openings and covering any tracks in the entries.

While the actual loading cost of coal extracted by means of conveyors at our No. 10 mine exceeded the cost of cutting and loading in wide work, yet the coal extracted was done without any additional cost for cleaning up, laying track or retimbering. The necessity for hauling from the working face was eliminated. Practically all the coal in these pillars was extracted and with a very small percentage of loss in timber. In one section of the mine, pillars were removed where the coal was low, over which there was no draw slate, roof coal or other material of this sort, it being a section with roof known as "slicktop," where the sandstone was immediately above the coal. Had we not used the conveyors in this section we would not have recovered any of this coal, as the coal was thin, and the roof had been blown down to allow the mine cars to be hauled to thicker coal beyond.

All the work done at this mine with the conveyor is in sections where the mining was done in a haphazard way years ago. Had the primary mining been done in a systematic manner, it would have been much cheaper and easier to remove the pillars with conveyors.

The exhibit is a portion of the mine showing a pair of butt entries, in which the entry stumps were allowed to stand for years. To clean up the entries in the ordinary way is expensive, but splitting the chain pillars with an 8-ft. entry as shown permits profitable recovery of the coal. The entry is driven its full length by using the conveyor. When the limit of the pillars to be recovered has been reached, we drive a 20-ft. room through to the old gob on either side of the entry, leaving a 6-ft. rib as indicated. The face conveyor is placed next to the rib in order to permit the drawing of same. This operation is continued until the pillars are drawn.




* Vice Pres. and Gen. Mgr., Pittsburgh Terminal Coal Corporation, Pittsburgh, Pa.

# METALS

## PRACTICAL OPERATING MEN'S DEPARTMENT

GUY N. BJORGE, Editor

*Practical Operating Problems of the Metal Mining Industry*

# METHODS OF MINE SAMPLING

*A Summary Of Data Received From Fifty-five Mining Companies, Including Most Of The Important Companies Of North America On Present Practice In Mine Sampling—Suggestions As To How Such Practice May Be Standardized*

*By* GUY N. BJORGE

THIS article will briefly review present practice in mine sampling as revealed by replies to the questionnaire of the Committee on Standardization of Methods of Mine Sampling; Methods of Recording Underground Geologic Data, and Methods of Estimation of Ore Reserves, Metal Mining Branch of the Standardization Division of the American Mining Congress. Replies to the committee's questionnaire were reveived from fifty-five mining companies, including most of the important companies of North America. A report on the Collection, Recording and Economic Application of Geological Data was presented by Philip D. Wilson, chairman of the committee, at the 27th Annual Convention of the American Mining Congress in 1925. Since the retirement of Mr. Wilson from active chairmanship, the committee has been relatively inactive. A report on Methods of Mine Sampling is in progress and should be submitted during this year.

The replies received constitute a large and valuable collection of data covering present operating practice. The material has been tabulated and arranged according to principal metals and to types of ore deposits. It is not within the scope of this article to give a full digest of this material, but rather to give a brief outline of what may be expected in the final report. The data collected is all directly concerned with sampling in mine development and production. Methods do not materially differ from those employed in mine examination, except in the matter of protection against intentional salting of samples.

Sampling is essentially a process of approximation. Its purpose is to obtain a small part or sample that is as nearly representative of the whole as practicable. The commercial sample can not be exact. The limit of care and accuracy in sampling must always be governed by the necessities of the particular case and by the cost and time involved in obtaining the sample. The care and accuracy with which any sample is taken must, then, depend on the purpose for which it is taken.

The method of sampling must be that which is suitable for the particular type of deposit and for the particular metal as well as for the purpose for which the sampling is done. There can, therefore, be no thought of the universal adoption of any strict, inflexible standards. But it is believed that a careful study of present practice with a liberal interchange of ideas will lead to some simplification and improvement of practice, both in the methods of taking samples and in the recording of results.

In mine operation sampling may be done for several purposes. These are:

1. Sampling in development for use in the estimation of ore reserves. In this, methods do not differ from methods employed in mine examination, except in the matter of guarding against intentional salting.

2. Daily sampling in stopes to control extraction and to determine the limits of minable ore. This may also include special samples of particular material to familiarize the taker with the value of that material. The latter is especially important where hand sorting in stopes is necessary.

3. Daily sampling from chutes or cars for record of ore extracted from individual stopes. This is followed by an automatic sample taken after crushing to correctly determine the grade of the total mine production.

Sampling for the purposes enumerated above is by no means general with all types of deposits. In certain deposits, of which the Lake Superior copper deposits are conspicuous examples, no practicable method of mine sampling, to determine the tenor of the copper rock mined, has yet been evolved, for the toughness of the native copper makes for extremely erratic samples. In certain other deposits, as for example with oxidized copper ores, the grade of the ore can be estimated from inspection

with sufficient accuracy to satisfy the requirements for controlling extraction. In these, too, records of production will often afford as good a basis for estimating the grade of ore remaining as can be gained by sampling.

The basic factors affecting the accuracy of sampling results are:

1. Spacing of samples. The proper interval between samples will depend on the uniformity of mineral distribution in the ore.

2. Position of sample cut. Intelligent interpretation of the geology of the occurrence is essential, except where the metal content of the ore is uniformly distributed.

3. Size of samples. To insure relative accuracy, the samples should be of generous size. Grab or pick samples should not be less than 10 to 15 pounds, and channel samples should be 20 to 30 pounds.

4. The segregation of minerals in the ore. Care must be exercised to assure the inclusion of the proper relative proportion of all material across the width samples. This is largely affected by the relative hardness and friability of gangue and valuable minerals.

5. The personal equation. Thorough training and close supervision of the samplers are essential for effective work.

In general, the responsibility for sampling is divided. Stope sampling to control extraction and chute sampling for production record are often done by, or under, the direct supervision of shift bosses, while development sampling is generally under the direction of the engineer or geologist. The size of the mine and the amount of sampling deemed necessary determine the personnel of the sampling crews. In small scale operations, sampling is usually done by the engineer or the superintendent. In larger operations the work is usually delegated to a special sampler or samplers. In general, all development samples, results of which will form the basis for ore estimates, should be taken by trained samplers. Where the mineral distribution is relatively uniform and the ore habits obvious, the samples should be under the direction of the chief engineer. Where the ore occurrence is more complex and the mineral distribution erratic, so that the intelligent interpretation of sampling results requires an intimate knowledge of the geology, the samplers should be under the direction of the geologist.

Stope sampling and sampling from chutes or cars is often left to the miner or the trammer because the workings are so scattered that it is not feasible to have such work done by special samplers. Wherever mine workings are sufficiently compact to make it possible to delegate such work to special samplers, the results obtained will, in almost all cases, be greatly improved.

The method of taking samples depends on the condition of the material to be sampled. Unless the ore is hard, or contains hard ribs, very satisfactory results may be attained by cutting a groove or channel with a prospector's pick or with a moil and hammer. In hard ore, and especially where many samples are to be taken in one place, machines of the Little David type (Ingersoll-Rand) equipped with moil bits, are recommended as great time savers. A chipping machine with 50 ft. of light hose can easily be carried by the sampler.

Stope samples to control extraction should be either chip samples, drill cuttings or grabs from piles, depending on conditions. Samples for production record taken at the chute are usually grab samples from the loaded car. This method may be improved by the use of a special, small, short handled shovel, to take samples from the tops of loaded cars.

In development sampling, an interval of 5 ft. between samples is practically standard in the non-ferrous metal mines. The desirable interval is somewhat dependent on the uniformity of mineral distribution and the purpose of the sampling. Under certain conditions it may be increased, but in no case is an interval greater than 10 ft. recommended. In the iron mines of the Lake Superior region an interval of 25 ft. for each sample is commonly accepted. The sample is cut in four grooves, two on each side of the drifts.

Where the mineral distribution is relatively uniform, as in most of the disseminated copper deposits, horizontal channels approximately four feet above the floor of the drift are recommended. In raises, channels may be cut in a horizontal ring around the raise. Wherever the valuable minerals are more or less confined to veinlets or controlled by any other structural feature, the sample must, of course, be cut at right angles to such structure. Where the structure is at all complex, care must be exercised to make the sample representative of the full width sampled and not merely a particular seam within that width. Valueless sampling, such, for example, as a side sample in a drift driven along a vein or a face sample, where a vein is being crosscut, is by no means rare.

All underground sampling needs periodic checking. Channel samples, if properly and carefully taken, should be practically accurate for the section represented. An average of 10 consecutive samples should check very closely with resampling of the same section. To insure against careless work in sampling, there should be periodic checking by taking a duplicate set of samples from selected locations. The accuracy of the samples in representing the value of the tonnage will depend:

1. On tonnage each sample represents.
2. On sampling interval.
3. On whether samples include full width to be mined.

At practically all of the larger mines, the grade of mine production is determined from samples taken automatically after the ore is crushed. This sample should be nearly exact and it serves to check all production samples taken underground. It is almost universally accepted that the production samples taken underground will be higher than the automatic samples. This is in part due to the personal equation, that is, to the "strange impulse that moves the most ignorant and disinterested workman to throw rich chunks into the sample." In part, it is due to the fact that grab samples contain an undue proportion of fines and that the fines are usually higher grade than the coarse material. The range of difference between the mine samples and the automatic samples is given as from 2 to 20 percent. With thorough training and careful supervision of all sampling it is believed that these samples can be made to check much more closely than is now the case. Where mine costs are calculated per unit of metal, it is essential that a correction factor for the mine samples be used. If such mine costs are to be correct, a new factor must be calculated periodically. This may be done at 10 to 30-day intervals, depending on the amount of variation in the factor.

Proper office record should be kept of all samples that have more than temporary value. In general, results of development samples are recorded on assay maps. Such assay maps should be kept of all important levels and intermediate levels. Where raising is vertical and regular, as in some of the disseminated copper deposits, assay sections are recommended. On all assay maps and charts, conventions that will indicate how the sample was cut should be used. Color conventions to represent material of various grades are recommended for better visualization.

Records of production samples are best kept on regular sheets suitable for the needs of the particular case. In most cases, they should be so arranged that the record is cumulative, so that the grade of ore from a particular stope for the current period and for its total production to date is directly shown.

The foregoing briefly touches on the material contained in the replies to the committee's questionnaire. Sampling practice must vary with the particular type of deposit and the particular metal. In the final (*Continued on page* 482)

*Rock-cement wall in Feather River, looking south from a point about 2 miles north of Oroville, Calif.*

*Primary gravel removed from the workings in H. F. Simpson's Shaft, 1 mile north of Bangor, Butte County, Calif.*

# AURIFEROUS PLACER RESOURCES OF CALIFORNIA

***Virgin And Undeveloped Placer Deposits Of California Of Amazing Magnitude—A Description Of California's Pre-Volcanic Gravel Channels Which Are Definitely Located By Means Of Magnetometric Determinations—Development Placer Resources On Scientific Basis Urged***

By ARTHUR GIBSON *

THE gradual decrease in recent years of California's annual gold production, from $22,442,296 in 1915, to $13,065,330 in 1925, would lead a person to the belief that the gold mines of California are fast becoming depleted. This is true with regard to the known and developed auriferous gravel deposits, most particularly the dredging fields. However, the virgin and undeveloped placer deposits of California are of such magnitude as to appear almost incredible.

The total amount of gold recovered in the State of California from 1848 to and including 1925 is $1,790,958,744, according to statistics compiled by California State Mining Bureau and United States Geological Survey. Of this amount it is generally conceded that about 80 percent was derived from placer deposits and only 20 percent from quartz mines. For a conservative estimate we will only credit one billion dollars worth of California's past gold production to placer deposits, representing less than 56 percent of the total.

Based on magnetometric determinations on virgin placer deposits, verified and supported by actual development work and proven values in numerous places, I have estimated that the total area of the placer ground which produced this gold covers less than 10 percent of the area of virgin placer deposits, yet undeveloped. Thus the value of California's anticipated future placer gold production will be in excess of $10,000,000,000. Even if we reduce this estimated amount to 50 percent or as low as 25 percent, to be over-conservative, it still remains a subject of sufficient moment to warrant investigation.

The virgin and undeveloped dredging fields along the eastern foothills of Sacramento and San Joaquin Valleys will produce more than 500 million dollars worth of gold; California State Mining Bureau estimates that between 600 and 1,000 million dollars worth of gold is available for hydraulic mining; northern California will produce its proportionate share. The major portion of this placer gold remains intact in the original auriferous graved deposits of the ancient pre-volcanic, Andesite and Basalt Lava-capped channels along the western slope of the Sierra Nevada Mountains and has to be recovered by drift mining.

These undeveloped auriferous gravel deposits will be described under three classifications: (1) Dredging Fields; (2) Hydraulic Gravel Deposits, and (3) Pre-Volcanic Gravel Channels.

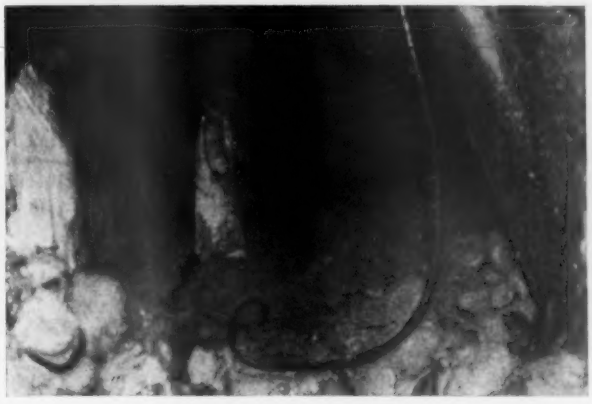
### (1) DREDGING FIELDS

It is a recognized fact that Sacremento and San Juaquin Valleys were at one time submerged under a salt water bay or sea. All developed dredging fields along the eastern foothills of said valleys line up and conform with the eastern shore line of this ancient bay and the bedrock underlying these various fields is virtually at the same elevation, ranging from 150 to 250 ft. above present sea-level.

The auriferous gravel deposits in every one of California's past as well as producing dredging fields, without exception, is of a secondary formation, having been eroded and removed from the primary channels and subsequently reconcentrated by the action of water in streams of a later age. The barren and lighter overburden on the pre-volcanic channels was naturally washed away during the early progress of the secondary formation; the heavier gravel and mineral concentrations were the last to be displaced and became thereby more exposed than in their original deposits in said ancient channels. This explains why the discovery of California's developed dredging fields, on secondary placer concentrations, occurred in advance of the yet undeveloped dredging fields on primary placer deposits. The fact that every known and developed dredging field along the eastern foothills of Sacramento and San Joaquin Valleys is situated at or along a stream of more recent age confirms this statement—for instance, Butte Creek dredging field at Little and Big Butte Creeks; Oroville dredging field, at Feather River; Hammonton dredging field, at Yuba River; Folsom dredging field, at American River; La Grange dredging field, at Tuolumne River, etc., all of said streams being of more recent age than the pre-volcanic channels.

As a rule, the auriferous gravel deposits in all developed dredging fields along the eastern foothills of Sacramento and San Joaquin Valleys rest on a false bedrock, which is another proof of their secondary nature. This fact is verified in Professional Paper No. 73, "The Tertiary Gravels of the Sierra Nevada of California," by Prof. Waldemar Lindgren, published by the United

* Mining Engineer.



*Auriferous gravel deposit, South Fork Mine, Plumas County*

*Tailing piles at Oroville, Calif.*

States Geological Survey, 1911, p. 220, which reads: "The gravels almost universally rest on a false bedrock of volcanic tuff or hardpan"—referring to dredging fields. One exception occurs at Butte Creek dredging field where Little and Big Butte Creeks have eroded down to the true bedrock in the ancient channel known as the Mammoth Channel.

The primary or pre-volcanic auriferous gravel channels entering Sacramento and San Joaquin Valleys from the western slope of the Sierra Nevada Mountains and which have served as feeders to the various primary dredging fields, yet undeveloped, are much more numerous than indicated on the maps attached to both Professional Paper No. 73 and Bulletin No. 92, "Gold Placers of California," by Mr. Charles Scott Haley, published by California State Mining Bureau, 1923. These primary channels, below an altitude of 1,000 ft. above sea-level, are of two distinct types, namely: (1) main primary channels, generally having a southwesterly course, and (2) spills or overflows from the main primary channels, having a westerly course, these latter may also be termed delta channels. There are more than 20 such primary channels in a distance of less than 200 miles along the eastern foothills of said valleys, which implies the same number of virgin primary dredging fields, and about 12 of these appear to be main primary channels. The gravel deposits in all of these primary channels rest on true bedrock.

The main primary channels are the most extensive, carry the best values with more or less coarse gold and the greatest mineral concentration in them is always confined on or close to bedrock, while the comparatively narrow spills or overflows carry rather light values of only fine gold scattered through the entire gravel deposit in horizontal layers with occasional higher grade pockets and generally devoid of any well defined mineral concentration (paystreak). These facts have been revealed in shafts sunk, at random, by miners and prospectors and tapping primary channels by mere accident.

It is evident, in view of these facts, that we can expect the dredging fields, fed by main primary channels, to excel all other dredging fields known and developed to date in said valleys, with reference to gold values.

The original lava capping on these pre-volcanic channels, when in place and undisturbed by later erosion, rarely extends below an altitude of 800 ft.

The presence of these pre-volcanic channels is generally revealed by the most positive and convincing superficial evidence along the surface between the break-offs in the original lava capping and the shore line of the ancient bay. By these surface indications it is even possible in many instances to determine beforehand whether the underlying channel is a main primary or a spill.

Surface indications of any pre-volcanic channel are naturally spread over a much greater width than that of its mineral concentration. It is not unusual to find the surface indications of a main primary channel extending over a width of one mile or more while its mineral concentration may only be a few hundred feet wide. The width of these surface indications increase more or less rapidly toward the short line of the ancient bay.

The location of the mineral concentrations in these pre-volcanic channels are not disclosed by surface indications, but as all primary auriferous gravel deposits contain a great deal of black iron sand it becomes a very simple matter to detect and definitely locate the said mineral concentrations by means of magnetometric determinations.

The depth from surface to bedrock in these primary dredging fields has never been determined, but the depth of all shafts on the primary channels, below a surface altitude of 1,000 ft., that have come under my observation is less than 100 ft.

Some of the primary channels may develop into ideal dredging propositions for several mines between the ancient shore line and the lava capping that remains intact.

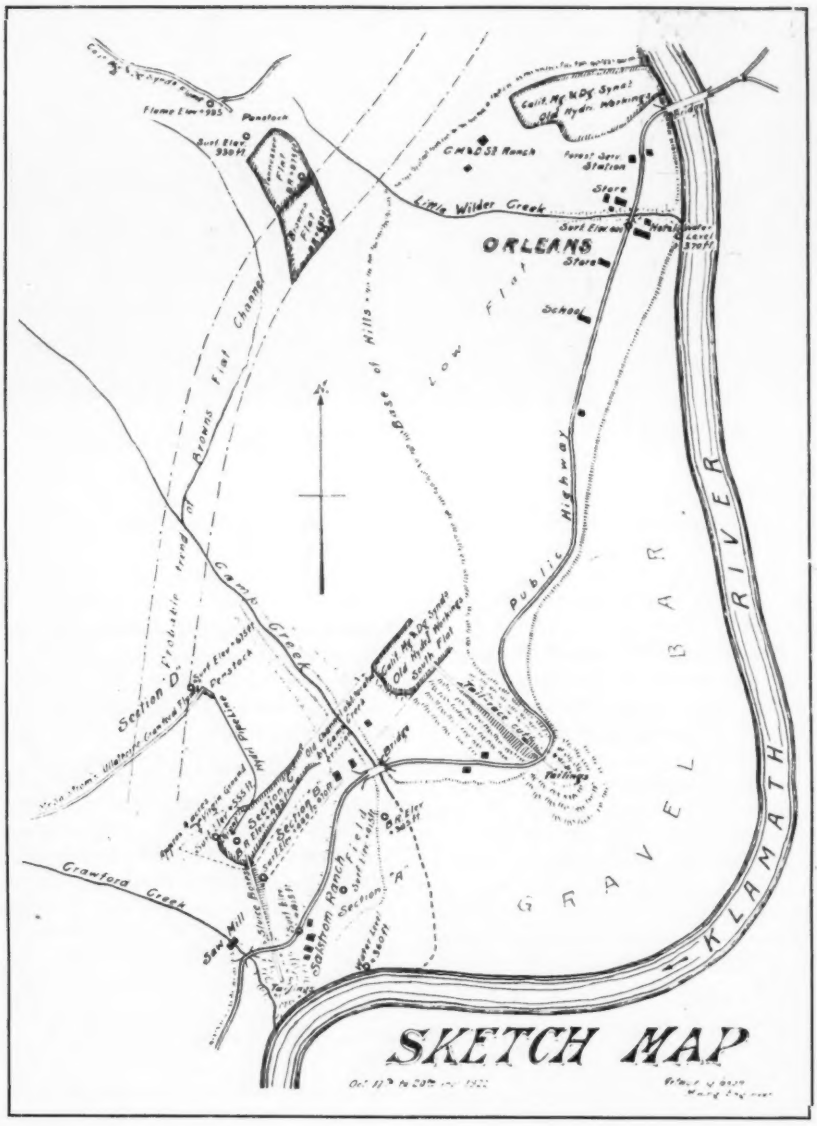
### (2) Hydraulic Gravel Deposits

The California State Mining Bureau has for some time been conducting an investigation to ascertain the possibilities of reviving hydraulic mining by the construction of large retaining dams to collect and impound the silt and debris in order to overcome the debris law, known as the Sawyer decision of January 23, 1884. The final results of this investigation have recently been made public.

The hydraulic gravel deposits occur both in primary and secondary formations, the latter predominating.

### (3) Pre-volcanic Gravel Channels

California's only pre-volcanic auriferous gravel channels in place and undisturbed by later erosion, except for occasional sections washed out and removed by the action of more recent water courses, are found along the western slope of the Sierra Nevada Mountains. These ancient channels are as a rule capped with either Andesite or Basalt lava, ranging in thickness up to several hundred ft., which has served as a protection against the erosive elements of nature. A pipe-clay deposit of volcanic origin, also ranging in depth up to several hundred feet, underlies the lava capping and overlies the gravel deposit. The gravel deposit, principally composed of white or blue quartz ranging from fine sand on top to large boulders on and near bedrock, varies in depth from about




50 ft. to 300 ft. or more. Total depth of these channels from the top or surface of the lava capping to bedrock varies considerably, not only in different channels but even in different sections of the same channel, a depth of 500 to 700 ft. is not uncommon although depths are known in excess of 1,000 ft. In some instances where the lava capping has been eroded off the depth from surface to bedrock ranges from less than 100 ft. to about 500 ft.

I have traced some of these ancient channels from the high Sierras to the valley floor, a distance of about 60 miles; their general course is southwesterly. Good values have invariably been recovered wherever the main pre-volcanic channels were tapped. Most of these main pre-volcanic channels appear to be entirely devoid of tributary feeders of auriferous gravel; as a matter of fact I have never found a tributary feeder so far. My magnetometric surveys show that these ancient channels have been paralleling each other very closely; the rims of their extensive mineral concentrations are in some places less than one mile apart.

The immensity of these ancient channels can hardly be perceived by a person who has not made a close study of them, even if he could realize the enormous volume of water they must have carried in order to remove the large and smoothly water-worn boulders, each weighing many tons, exposed in developed placer mines at altitudes as high as 5,000 to 6,000 ft., and their vast quantity of smoothly water-worn quartz gravel deposits with the well defined and thick mineral concentrations, which latter in places reach a width of almost one mile from rim to rim. The major portion of their water-flow appears to have been derived from some source in or beyond the high Sierras. Their smoothly water-worn hard quartz gravel indicates that it has traveled a long distance.

The mystery surrounding the actual source of these ancient channels with their valuable auriferous gravel deposits is going to be definitely solved by means of magnetometric determinations in a not very distant future.

Each one of these ancient channels possess certain individual and distinct characteristics pertaining to the lava capping, pipe-clay or gravel deposit, which, when known, will serve to identify each separate channel wherever tapped along its course.

There are probably more than 2,000 miles of these ancient channels, along the western slope of the Sierra Nevada Mountains in California, containing virgin and undeveloped pre-volcanic auriferous gravel deposits.

Paystreaks 5 to 7 ft. in depth, averaging around $20 per cubic yd. or $2 to $5 per sq. ft. of bedrock in gold, are not uncommon in the main pre-volcanic channels. One and one-half miles of the ancient channel at La Porte, Plumas County, Calif., is reported by good and reliable authority to have produced more than 16 million dollars worth of gold, thus averaging better than $2,000 per lineal ft. of channel. The extensions of this La Porte channel were lost by reason of a fault cutting and shifting it in the upper end and a more recent stream washing out a section in the lower end. The phenomenal gold values recovered from some of these ancient pre-volcanic auriferous gravel channels are mentioned in Professional Paper No. 73.

The auriferous gravel deposits in the main pre-volcanic channels along the western slope of the Sierra Nevada Mountains always rest on true bedrock, are confined within well defined limits, their gold values are concentrated on or near bedrock and average much higher per square foot of bedrock than in the secondary formations, which latter invariably rest on a false bedrock and are scattered over a larger area.

All of these primary gravel deposits are as a rule found water-logged when first opened up, but after the water is once pumped out and the ground drained there is generally very little water to contend with. Faults, as well as sections eroded out of the ancient channels below their bedrock floor, have cut off all continuous water-flows in said channels and the pipe-clay and lava capping seals the gravel deposits from any surface seepage.

That these valuable and extensive auriferous gravel deposits are lying dormant and remain undeveloped may seem rather strange, but it is principally due to the faulting of the surface, caused by

*La Grange Gold Dredging Co.'s Dredge No. 2 on Tuolumne River at La Grange, Stanislaus County, Calif. Buckets, 9 cu. ft.; average daily capacity, 6,500 cu. yds.*

*Panorama showing Basalt Lava Capping, still intact, on the Ancient Oroville Primary Channel, 2 to 3 miles north of Oroville, Calif. Looking north*

*Tennessee Flat, bedrock elevation 875 ft. above sea level, looking northwest, situated east of Orleans, Humboldt County, Calif. See sketch map, upper left hand corner. This bench was worked by Orleans Bar Mining Co. Present owners, California Mining & Dredging Syndicate*

*Westerly edge of immense tailing piles at the Hammonton dredging field on Yuba River, Calif. Looking east. More than 400 million cu. yds. have been handled in this field and it is now about 75 percent worked out*

volcanic disturbances, and the consequent cutting off and shifting of the channels, combined with the excessive cost of locating their displaced extensions underneath a very thick and hard lava capping. In some places where a section of the ancient channel has been eroded out and washed away, below its bedrock floor, by a later cross-channel, the extension may have become covered up and hidden under a slide, dense vegetation or forest. The mineral concentrations in these displaced and concealed ancient channel extensions are readily detected and definitely located with the least loss of time and at a minimum expense by means of magnetometric determinations.

The ancient auriferous gravel channels in northwestern California were not protected by a lava capping and consequently later water channels have eroded them away almost entirely, only leaving occasional benches of comparatively small extent containing remnants of the old channel beds, situated at various elevations ranging up to more than 1,000 ft. above the present river beds. Only the benches at the highest elevations contain remnants of the primary auriferous gravel deposits in place, the lower benches are all of a secondary nature having been cut out and left behind as the later channels gradually eroded down to their present levels. Some of the higher bench gravel deposits are reported to contain good values of gold, but as there is no available gravity water supply with which to work them they are of no commercial value until a practical method is devised for handling the gravel or water is brought to them by artificial means. All of the original auriferous gravel from these ancient channels, excepting that which still remains in the aforesaid benches, was washed away and carried along to lower levels by the erosive action of later streams. A portion of this auriferous gravel now forms more or less extensive hydraulic gravel deposits while the balance of said gravel has been reconcentrated over limited areas in bars and on the bottom of present river beds where dredges, as a rule, are the only means employed to recover the mineral values. The gold values in these secondary formations do not average as high as in the primary channels on the western slope of Sierra Nevada Mountains.

The opportunities for highly remunerative investments in the development and operation of California's virgin primary placer deposits are as good today as they ever were.

With the development of the extensive placer resources in California, on a scientific basis, the annual gold production should, within the next 3 or 4 years, reach a figure several times higher than that of 1925.

# COAL

## PRACTICAL OPERATING MEN'S DEPARTMENT

NEWELL G. ALFORD, Editor

*Practical Operating Problems of the Coal Mining Industry*

# GROUTING METHODS EMPLOYED IN SINKING THE HARWICK COAL & COKE COMPANY SHAFT

***Construction Joints The Weak Point In Concrete Shaft Lining—Grouting Accomplished With Weak Solution Under Low Pressure Graduated To Thick Cement Under High Pressure—Success Dependent Upon Maximum Introduction of Heavy Grout***

*By* E. T. GOTT *

AT A MEETING of the Mining Section of The Engineers' Society of Western Pennsylvania, in the fall of 1925; and in the discussion of a very able paper by Mr. Newell G. Alford, of Pittsburgh, on the Failures of Concrete Lined Shafts in Western Pennsylvania, this opening for the Harwick Coal and Coke Company—then in its early sinking stages—was discussed and much interest manifested in the proposed method of grouting the water that was then being encountered; and in the design of the construction joint between successive runs of lining, conceived by John M. Rayburn Company, the engineers for the coal company.

This joint, as is generally known, is the weak link in any concrete lined shaft, and the point at which leaks are most likely to develop and correspondingly the first to show signs of weakness and inefficiency when the grouting pressure is applied.

Our contract with the coal company considered the sinking and concrete lining of a combination air and slate-hoist shaft, approximately 285 ft. in depth from coping (10 ft. above ground) to the bottom of the Freeport Coal Series and included the furnishing and placing of guides, buntons, brattice and stairway, all of timber, and conforming in every detail to modern shaft design. Included also under our agreement, was the excavation and concrete in the arches, extending three ways from the shaft bottom, 20 ft. back from the face of the lining on the two sides opposite the cage ways and 16 ft. off the end of the shaft at the air compartment.

This opening, as indicated on the drawing, is rectangular in section, 11 ft. 0 in. by 23 ft. 0 in. inside dimensions, with a 6-in. fillet at the four corners, giving a net inside area of 252.5 sq. ft. The outside coping dimensions are 17 ft. by 29 ft., allowing for a 3-ft. 0 in. thickness of concrete and extending, unchanged in dimension, through a rotten shale to solid rock 26½ ft. below average ground.

In rock, we stepped-in to the 12-in. contract requirement, giving a neat section of 12.03 yds. per vertical foot, to which the normal overbreakage to be expected was added. Our estimate, therefore, considered 13.0 yds. in excavation, but due to the occurrence of four bad stretches of fire-clay, the section in rock actually ran 13¾ yds., which proportionately increased our concrete quantities and resulted in an average lining thickness of 19 in., as against the theoretic 12 in. called for on the plans.

These figures are offered to give an idea of the size of the shaft, the average thickness of the lining against which our rib grouting was done, and the exposed area at the shaft bottom (371 sq. ft.) in connection with the down-hole drilling and grout injection.

Through the fire-clay sections, mentioned above, the rib began to slough-off dangerously as soon as the air hit it, so that, for the safety of the men and to prevent further enlarging the section, short 25-ft. runs of lining were imperative. In the 275 ft. of shaft, below the surface, seven (7) closures were therefore necessary, with the last one at 220 ft. and 5 ft. into the sandstone overlying the Freeport coal. The last run of lining was not poured until the bottom arches were in place, thus tying in monolithically this bottom concrete with the work in the shaft above it.

In the first 40 ft. of sinking there was practically no water encountered—our measurements showing one-fifth of a gallon per minute after this 40-ft. coping section had been poured. This seepage followed us through our second concreting, increasing gradually to 8 gallons per minute when the excavation had reached 66 ft. These feeders had all been carefully panned and connected to grout pipes leading through the concrete at convenient points, and were allowed to drain freely into the shaft.

Working from the 70-ft. level, our

* Vice president, The Dravo Contracting Co., Pittsburgh, Pa.

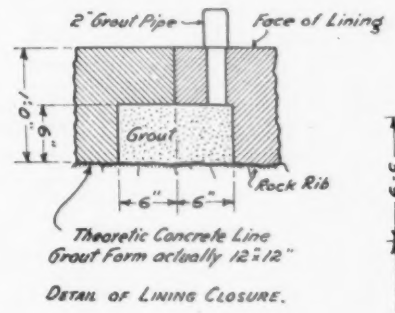
drills uncovered 60 gallons per minute at 76 ft. with a 6-ft. solid formation between the shaft bottom and the water-bearing stratum. These holes were drilled out to 10 ft. and plugged, and about 20 others, uniformly distributed over the entire bottom, were put down to this same level. Each hole in turn was then opened and a 2-in. grout pipe (tapered slightly and provided at its outer end with an iron stopcock), was driven into position. To prevent its being blown out under pressure, the tapered portion of the pipe entering the hole was "ragged" and to insure a perfectly tight joint, was wrapped with burlap.

With the water thus under control, the grout tank was set up and connection made to one of the pipes, opening (as vents) all others that were found to be communicating. The hole was then "blown" thoroughly with air and the injection of a weak solution of neat cement started, using only the pressure required to discharge the batch and allow it to find its way to one of the communicating holes. All others were then closed and the mixture gradually richened until a thick creamy grout was being injected. The stopcocks on the vent were then turned and the pressure behind the succeeding batches run up to 125 lbs. and the operation continued until no more grout would enter.

All of the holes were sealed in this way and each pumped to refusal. If within a short period the opening of any of the cocks showed the presence of water, it was given a second shot, and in some cases a third was found necessary.

This seam at the 76-ft. level was a small one, admitting only 137 sacks of cement. The grout was allowed to set for a day and a half, when all cocks were opened, pipes removed and sinking resumed. In the drilling of the sump which followed, no water showed up, but after the benches and back rounds were shot and mucked-out, we were making 12 gallons per minute, showing that of the 60 gallons per minute that had been opened up, the flow by this down-hole method of grouting had been cut to 4 gallons, after deducting the 8 gallons the shaft was making when this vein was struck.

These 12 gallons followed the sinking, increasing possibly to 18 gallons as a maximum when the coal was reached. Of this amount 10 to 12 gallons were coming through grout holes at the closures and through the random pipes in the shaft, while the remaining 2 to 6 gallons per minute was "sweating" at spots that had either been insufficiently panned or in being trapped back of the lining, had forced its way through the



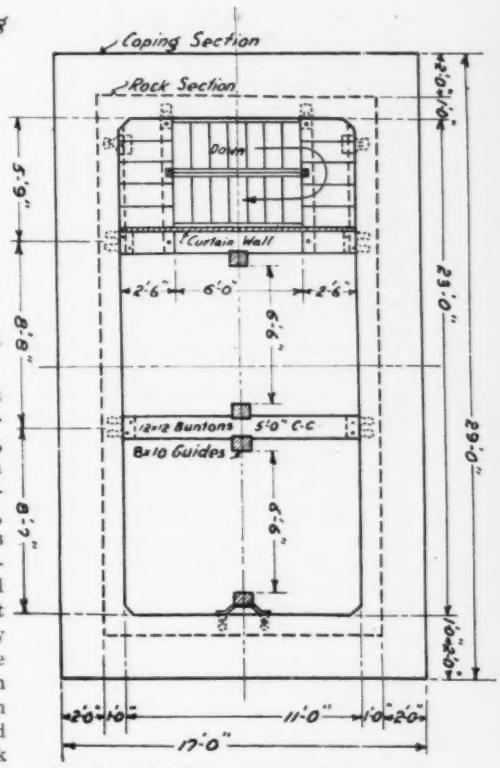

DETAIL OF LINING CLOSURE.

green concrete before it had set sufficiently to resist it.

The formation of the construction joint, first above mentioned, was accomplished in two separate operations, which may be outlined as follows: When the sinking had been carried the prescribed distance (40 ft. in good ground), the loose muck on the bottom was leveled and the first of eight 5-ft. collapsible forms was placed in the usual manner. At the bottom of this first form, one-half of the joint (6 in. by 6 in.) was formed around the entire periphery of the shaft, 6 in. back from the face of the lining, with its bottom open and resting on the loose muck and its top tightly sealed against the rock rib. At 2-ft. intervals, and near the top of the cavity thus formed, 2-in. pipes were placed with their inner ends tapping this pocket and their outer flush with the face of the lining and provided with sleeves to which grout connections were later to be made, all of which is well shown on the accompanying drawing. The eight forms in successive 5-ft. lifts, were then poured and at the closure onto the section next above it, a similar 6-in. by 6-in. half-joint was constructed membering with the one that had been formed at the bottom of the preceding pouring. We thus had, at each closure, a 6-in. by 12-in. opening around the entire shaft, with the joint between the two successive runs of lining midway of it.

After the concrete had seasoned, it was planned to fill this cavity to refusal with neat cement grout at low pressure through the 2-in. connections above described. At Harwick these pipes were allowed to drain freely until we were prepared to do this rib-grouting, it having been thought advisable to make use of the 12-in. by 12-in. buntons in the support of the relatively weak sides of the shaft, before applying the pressure, and these timbers could not be conveniently placed until all of the bottom work had been completed and the lining below 220 ft. closed in.

The shaft was, therefore, left in this condition with all grout cocks open, until the work on the bottom was completed and the two lines of buntons placed, and




securely wedged against the sides of the shaft.

A start was then made on the grouting of the rib, moving from the top downward, in order that we might closer observe the effect of our work, which would not have been possible had we started at the bottom, as is ordinarily done in this final treatment of the lining.

No trouble was experienced, and the face of the concrete was completely dried up, until the third closure at 105 ft. was reached. Here, as at the ones below it, the hydrostatic pressure was found to be too great for the 6-in. shell in front of the construction joint, which we then found had to be subjected to greater pressures than were originally conceived in its design. Accordingly, before the grout connection was made, stout walers were run along the two sides of the shaft (opposite the joint), cross-braced and securely wedged into position. Similar precautions were taken at the random holes in the lining to which connections were also to be made.

After having treated the last closure at 220 ft., it was found that in addition to the two lines of 12-in. by 12-in. buntons on 5-ft. vertical centers, we had placed 47 complete sets of walers and cross-braces; had injected 1,051 batches of neat cement grout, and had spent nearly a month in our effort to seal off this water, knowing that whatever was left in the shaft would have its bad effect upon the concrete. In this operation we had grouted to the limit of the

strength of the lining, and while the final readings show that the water had been cut to three gallons, yet we are reminded, after the reports of so many failures, that no concrete lining through which water is finding its way, can possibly have a long life, and our most recent effort must (for this very reason) be regarded as a doubtful success.

After studying the possibilities of grout, since its introduction into this country, and experimenting with its application to sealing water-bearing strata in shafts, the results from this job, and many others of similar cross-section, show the impossibility of successfully treating a rectangular opening. On the other hand, we are firmly convinced that circular and even elliptical shafts can be sealed if proper methods are used, skillful men employed and careful attention given the panning and complete drainage of all water as the concrete is being placed, even to the extent of making this backwalling solid and continuous through sections that are extremely wet.

Our experience has also taught us that only a concrete of maximum density, and not less than 1:2:3½ mixture, should be used, with a careful observance of the water ratio. The minimum lining thickness should be 24 in. in wet ground, with 8 in. to 12 in. in sections that are perfectly dry.

In our opinion, it is this unpanned water working through and acting upon the linings of shafts, with its freezing and subsequent thawing in winter, that eventually breaks down the structure of the concrete and is the direct cause of the many failures that have been recorded to date. In this connection should also be noted the undoubted bad effect of this uncontrolled water on green concrete, as the form is being filled and the point at which it enters the shaft, cut off. A pressure is at once recorded and soon builds up sufficiently to force its way through the lining before it has sufficient strength to resist it.

You will notice in the long list of failures that have recently been compiled by Mr. Alford, that water in varying amounts was encountered in all of them, and if the methods employed are looked into, you will find that the grouting (if done at all) was very perfunctorily performed and had been stopped or limited in most cases by the owners themselves with the thought that the few remaining gallons left in the shaft could not possibly bother them, and could very easily be handled by their mine pump, the importance of carrying this operation to the limit not having been impressed upon them at the time. It must be admitted that the getting of this "last drop" requires a great deal of effort and correspondingly adds to the cost of the work, but it *can* be shut off, and unless it is will have its bad effect upon the lining.

Much condemnation has been heaped upon concrete as a lining medium, undoubtedly because of the indifferent methods heretofore employed and a lack of observance of the principles outlined herein. Some engineers are experimenting with vitrified brick and hollow tile. In several relining jobs brick has been used, and on a very recent development in Ohio, the owners have shown their preference for this material in the lining of their two 450-ft. openings.

In repair and relining jobs, where the concrete has disintegrated due to the presence of water and where simply an impervious facing is required to build it up to its original dimension, brick can not be improved upon. The very small amount of water that would ordinarily be found in a shaft under such circumstances, can easily be conducted back of the brick, to the bottom, and would give no further trouble. In new developments, however, where large flows are to be expected, the brick can only be placed with difficulty and at excessive cost; and the mortar joints under such unfavorable working conditions, must be of doubtful strength and efficiency.

In this type of lining no attempt is made to cut off any of the water, and it is either allowed to fall back of the brick to the bottom or is conducted to water rings in the shaft—in either event necessitating its being pumped for the life of the mine. This fact alone should warrant careful study and economic analysis.

We are, therefore, still unconvinced that brick is an improvement over concrete, or that a concrete lining can not be put in that will remain permanently watertight, providing its design will admit of heavy pressure, the water handled properly, and the grouting intelligently and thoroughly done. Until such a test is given it we are unwilling to condemn it. Certainly our present method is no criterion.

## PANEL DEVELOPMENT WITH MECHANICAL LOADERS FOR RETREATING METHOD

(*Continued from page* 471)

By carrying out the above sequence the entries reach their limit at about the time the pillar line is ready to begin taking coal from the entry section.

When the farthest rooms of No. 3 entry reach their limit pillaring is started by the loading machine and continued until a pillar line is established with sufficient size to work seven or eight hand loaders. Then the hand loaders are put to work on the pillars and the loading machine is started to working rooms in advance of the pillaring.

Pillaring methods by loading machine and hand loaders are identical—the lift method being employed. A place 14 ft. wide is driven across the back of the block to be pillared. This place is driven so that a slab 7 ft. thick will be left next to the gob. When the place is driven through, the slab is removed by taking off successive "lifts" and permitting the roof falls to follow closely after. After the slab is removed another similar operation is started.

No effort has been made at this mine to carry an extensive pillar work by loading machines, because development has been the major objective to date. However, from the pillaring that has been done, it appears that it would be possible to do pillaring, but at the expense of reduced efficiency of operation as compared to that in development work. Safety would also be a serious issue, because of the machine noise prohibiting hearing of roof warnings, which is something very important in this coal seam. The reduced efficiency in tonnage is about 10 percent below that in development work.

During 1926 the loading machines at this mine averaged 110 tons per machine shift, including all machines and not excluding time lost for any cause. The regular eight-hour shift is standard.

Time studies of the machine's operation showed the following distribution of the 480 minutes of each shift:

| | |
|---|---|
| Actual loading time of machine | 168 |
| Lost account time shifting cars | 77 |
| Lost account time misc. car loading | 34 |
| Lost account time shot firing | 24 |
| Lost account time derailments | 10 |
| Lost account time loader trouble | 38 |
| Lost account time waiting on empties | 64 |
| Lost account time moving machine | 63 |

## METHODS OF MINE SAMPLING

(*Continued from page* 475)

report it is intended to give a resume of present practice and the committee's opinion as to the best practice for the various types tentatively grouped as follows:

1. Copper Deposits. (a) Lake Superior Type. (b) Disseminated Deposits. (c) Vein and Replacement Deposits.
2. Lead and zinc mines where silver and gold values are subordinate.
3. Lead and zinc mines where silver and gold values are vital.
4. Complex ores—lead, zinc, copper, silver.
5. Iron deposits.
6. Precious metal deposits.

The report will reproduce such forms and charts submitted with the questionnaire replies as are deemed especially good.

Suggestions as to the best practice for any phase of sampling and additional data from any company that has not previously replied to the committee's questionnaire will be welcomed by the committee. These may be sent to the writer, who is acting chairman of the committee.

For improvement in sampling results, methods should tend toward more careful sampling and the elimination of samples taken by those not competent to take samples which are representative and reliable. This means more thorough training of samplers and closer supervision of all sampling work.

# NEWS OF THE MINING FIELD

*A Resume Of The Activities Of The Mining Industry And Items Of Interest In The Field*

### Calumet and Arizona Takes Over Lead Property

The Gopher group, consisting of eleven claims, located near Fantano, Arizona, and owned by the Hiltano Mines Company, has been taken over by the Calumet and Arizona Mining Company of Warren, Arizona. The property has been developed by E. P. Hilton and during the past year was a fairly important lead producer.

### Shattuck-Denn Reelects

At its annual meeting the Shattuck-Denn Mining Corporation re-elected the entire board of directors and officers for the coming year. No new plans were taken up in regard to further development work or method of operations. Shattuck is engaged in sinking its main shaft to the 2,000 level.

### Eastern Oregon Mining Bureau

The Eastern Oregon Mining Bureau will be organized at Baker on June 6, it has been announced by William E. North, secretary-manager of the Baker County Chamber of Commerce. It is proposed to affiliate with the Northwest Mining Association and establish a listing and information service. Blaine Hallock, of Baker, is chairman of the organization committee, the other members being John Arthur, D. W. C. Nelson, Jack O'Keefe, and Bernard Kempfer of Baker, Robert Betts of Cornucopia and Frank A. Kennedy of Homestead.

### Snowstorm Concentrator Burns

The 400-ton concentrator of the Snow Storm Silver-Lead Company, built at Troy, Mont., about 11 years ago at a cost of $130,000, was burned recently. The fire is believed to have started in or near the flotation department, where much oil is in use. The equipment was modern. The loss is partly covered by insurance.

M. H. O'Connell, M. V. Messenger, and H. B. Rosenbaum, who are driving a 200-foot tunnel to tap the ore in the Crystal Mine at Miles, Wash., are progressing rapidly, having the tunnel about half completed. The ore is silver-lead-zinc and took the prize at the St. Louis Exposition for its high quality.

## POSSIBLE CAPITAL STOCK TAX REFUND

IT IS reported that a test suit will be brought in the U. S. Court of Claims for recovery of capital stock taxes paid by a corporation whose only activity is holding title to timber land. In a number of decisions the Federal courts have held that such activity is not doing business within the meaning of the capital stock tax law. But the Treasury has continued to deny claims for refund and has refused to amend the regulations. It is understood that acquiescence in the Federal court decisions would result in refunds of $25,000,000 to perhaps $30,000,000, which soon will be outlawed by the statute of limitations which provides that claims for refund must be filed within four years from date of payment of the tax. The years 1923, 1924 and 1925 are still open. As to the year 1923, the taxpayer has until July 1 of this year to protect his rights, in the event of a favorable decision by the Supreme Court. If any corporations in the mining industry were merely holding title to mining lands during the years above mentioned, and were not engaged in mining operations or any other activity for profit, but who nevertheless were required to pay the capital stock tax, they are advised to protect their rights by filing claims for refund which will serve to hold their cases open until the matter has been finally decided by the Supreme Court. The Tax Division of The American Mining Congress invites inquiries where further information is desired.

### Litigation Ended

Litigation between the Nenzel Crown Point and the Rochester Silver Corporation, Rochester District, Nev., has been ended by District Judge Frank P. Dunn, who has rendered judgment in favor of the latter company. The court's ruling permits the Rochester Silver Corporation to resume operation of its mine and mill at Rochester. Arrangement has been made for the operation of the property by Bennett and Emminger under a lease agreement.

### California Hydraulic Mining Bill Defeated

The Cloudman Bill providing the preliminary steps for the resumption of hydraulic mining in California under the supervision of the California Debris Commission was defeated by a single vote in the state senate. It had previously passed the assembly by a liberal margin. The heavy hand of the state administration aided in defeating the bill.

The principal opposition to the bill came from the Sacramento Valley agricultural interests. In the campaign against the bill a strong appeal was made to arouse the old prejudice against hydraulic mining. Misinformation spread the fear that resumption of hydraulic mining in spite of adequate restraining dams would result in ruin to agricultural interests and in further hindrance to navigation because of building up of river beds by deposition of the debris.

The next step in the attempt to rehabilitate hydraulic mining will have to be made in Congress and will require that a report be submitted to Congress by the California Debris Commission.

### California Mining Notes

After seven years of effort, J. M. Pitts of Magalia, Butte County, struck the old Magalia channel at the end of the 2,300-foot tunnel. The mine is known as the Lillian Mine and Pitts is said to be netting $450 a day from the clean-up of the placer, which is very rich.

The Black Bear Consolidated is going ahead with plans to build a restraining dam at Steep Hollow, Nevada County, on the Bear River, for the purpose of hydraulicking. Permission has been received from the California Debris Commission for the work.

A. H. Betham, interested in mining in the Feather River section near the mouth of Bear Creek, announces that he will put a force of miners to work soon, and is now waiting for the snow to clear off of a placer property in that district.

The American Flag Mine in the Camptonville section will be opened up soon, according to James Grimes, a part owner in the property. A contract for putting in a tunnel has been let and a number of tons of good quartz ore are ready for milling already.

The Four Hills Mine above Johnsville

in Sierra County has been bonded to McGonigle & Hinchner of Downieville, and these men plan extensive development. This is an old mine with a long record of production.

The inside shaft sunk from the tunnel of Forest-Alleghany, at Alleghany, is now down 200 feet and near an extension of the famous Sixteen-to-One gold vein which has produced many millions.

A pine cone estimated by the Carnegie Institute to be at least two million years old has been found at You Bet by L. G. Beloud, under a lava capping.

William Ring, of Downieville, has five men working on the Hilda property.

The Rattlesnake gravel property near Downieville has been bonded to the Weepah National Mines Company by Edward Deal. Leases run for three years and work must commence within 30 days.

### Spokane Mining Bureau Meeting

At a recent luncheon meeting of the Mining Bureau of the Spokane Chamber of Commerce, reports were submitted by a number of operating properties by men interested, and several subjects effecting mining were discussed, including the zinc smelting situation. The opinion was also expressed that the recent burning of the Snowstorm flotation plant at Troy, Mont., will be a serious loss to many properties, some of them as far away as Stevens County, which had their ores reduced at the Troy plant.

Frank M. Smith, smelter director of the Bunker Hill smelter, with offices in the Paulsen building, Spokane, and chairman of the mining committee, said that his company was not in a position at the present time to take complex ores and that the Bunker Hill will not be able to relieve this situation until its new zinc plant is in operation later in the year.

### Ontario Government Will Explore Mineral Areas

The Minister of Mines for the Province of Ontario has announced that nine geological parties will make thorough explorations of different mineral areas of the province this summer, according to advices to the Department of Commerce. Four of the parties will be led by Mr. A. G. Burrows, provincial geologist, and three assistants, while the others will be under professors of geology. The party under Mr. Burrows will explore the lead-zinc-copper finds of the Sudbury Basin. Other parties will go to the Lake Savant area, to the Beardmore area, to Kirkland Lake and to the district north of Larder Lake, where copper-zinc-lead discoveries have been made. Investigation will be made of the lead, zinc, and silver finds northeast of Sault Ste. Marie. A party will explore the Mattagami-Abitibi area for china clay and coal deposits and reported discoveries of ore containing high values in nickel and platinum in the Lake Shebandowan and Moss Township area will be looked into.

**THE following account from the Joseph A. Holmes Safety Association is one of the frequent illustrations of the value of the first-aid training given by the Bureau of Mines:**

**"On May 9, at 7 a. m., the U. S. Bureau of Mines, Pittsburgh Station, received a call to assist in reviving Mr. J. Wickenhauser, who resides in the Pittsburgh district, and who had been overcome by gas fumes from a gas stove in the basement of his home. Messrs. Davies and Burdelsky, of the Bureau, answered this call and upon arriving at Mr. Wickenhauser's residence started giving him artificial respiration. After working on the man for about 30 minutes, he was able to breathe without any further assistance, and was left in the care of his physician, who said the patient was much improved and had a chance to recover providing he did not take pneumonia. These men are to be commended for this successful treatment, as their work has helped to give this man a fighting chance to live, due to the fact that, upon their arrival, the doctor claimed the man was beyond recovery."**

### New Mill Under Construction

The Tenabo Consolidated Mining Company has begun construction of a fifty-ton mill at its property at Tenabo, south of Beowawe, Nevada. Concentration will be by flotation and mill equipment includes a crusher, ball mill, classifiers, thickeners and flotation cells. A Diesel engine will supply power.

The management reports that the vein has been cut on the 137-foot level and developed for a length of 350 feet. Water suply has been developed in the Gold Quartz and Phoenix shafts. The Gold Quartz was recently opened after a shutdown of twenty years.

### Coeur d'Alene Profits

Profits of $7,957,901 were made by the producing mines of the Coeur d'Alenes in 1926, according to sworn statements filed with the county assessor as required by the Idaho law. The total production was $24,630,201. The production for 1926 was heavier than in 1925, but profits were about $800,000 less than in 1925, due to the lower prices of metals during a portion of the year.

The list of producers and the net profits as submitted follow:

The Morning mine of the Federal Mining and Smelting Company, gross value, $8,018,027; net profits, $2,543,605.

Wyoming lease, near Kellogg, Federal Company, gross value, $15,054; net profits, $1,128.

Frisco mine, Federal Company, gross value, $173,955; net profit, $18,134.

Bunker Hill & Sullivan, gross value, $7,202,042; net profits, $2,527,116.

Bunker Hill, Crescent mine; gross value, $202,305; net profit, $110,393.

Hecla, gross value, $5,479,367; net profits, $2,459,927.

Gold Hunter, gross value, $571,542, net profits, $56,614.

Caledonia, gross value, $48,066; net profits, $4,913.

Sunshine Mining Company, gross value, $257,793; net profits, $65,569.

Sheridan lease, at Morning mine, gross value, $387,086; net profits, $14,042.

Stratton Mines Company, gross value, $178,026; net profits, $62,338.

Tamarack & Custer, gross value, $1,198,332; net profits, $27,000.

Sidney Leasing Company, gross value, $16,884; net profits, $14,277.

Hypotheek, gross value, $157,139; net profits, $34,942.

Douglass, gross value, $10,304; net profits, $8,091.

### Silica Refining Plant Planned

Commercial production of refined silica will soon be begun by the Mount Shasta Silica Company, of Weed, Siskiyou County, California. J. M. White, Manager of the Long Bell Lumber Company at Weed, who was recently elected President of the Mount Shasta Silica Company, says the site is cleared near Pit No. 3, on the Pit River, for the construction of a one-unit refining plant of a daily capacity of 50 tons. The plant will cost approximately $50,000. The company has already shipped three carloads of crude silica from its property in Shasta County.

### Production Increased

Production of zinc concentrates from the Afterthought and Bully Hill Mines of the California Zinc Company has been materially increased. More men have been added to the underground crew and plans for development in new territory approved. Zinc concentrates from the Winthrop plant are being shipped to Belgium and Germany.

J. F. Dugan, General Manager, has resigned and will return to the service of the Anaconda Copper Mining Company at Butte. E. L. Ralston will succeed Mr. Dugan as Manager.

### Oregon Mercury Mine Shipping

The mine of the Mercury Mines Company, located in Oregon, about twenty miles northwest of McDermitt, Nevada, is producing eighty-five tons ore daily. Mercury production is at the rate of four hundred 75-pound flasks monthly. Plans have recently been approved for additions to the power plant and general improvement of the camp.

The property is controlled by F. W. Bradley, of San Francisco.

### Jack Waite Resumes Shipments

The Jack Waite Leasing Company, recently resumed shipments from its property on Eagle Creek, in the Coeur d'Alenes. On account of the condition of the roads, no hauling was done after March 28. The mill has been kept running and the product was stored until trucks could operate. Two trucks are on the job. This company, which was in debt when it began work last fall, has since cleaned up its indebtedness and has about $15,000 in its treasury.

### Colorado Fuel & Iron to Rebuild Furnace

Announcement that Colorado Fuel & Iron Co. will commence the rebuilding of its open-hearth furnaces at Pueblo on July 1, with a view of increasing the capacity to 1,000,000 tons of steel a year, is generally accepted as meaning that further extensions in its manufacturing department are contemplated. The company recently completed improvements costing $5,500,000, including a new structural steel mill unit. Before additional units are built, it is understood it is considered necessary to increase the quantity of raw steel available for use. It will require from one and one-half to two years to rebuild the open-hearth furnaces, and in the meantime it is expected that plans for further expansion will mature.

### New By-Product Oven Being Tried Out At Sykesville Plant

Mining operations at the Sykesville mine of the Cascade Coal Company, Sykesville, Pa., have been suspended for an indefinite period and it is the opinion that the plant will not resume for a month, possibly two.

Extensive experiments with by-product coke ovens will be carried out at the Sykesville plant. The company has recently installed four ovens of a new design that are practically the first of their kind to be tried in the whole world. The ovens are operating upon the principle of indirect heat applied to the bottom of the charge of green coal, instead of to the sides as is common in the general run of by-product plants.

## MINE SAFETY AND MINE SAFETY CODES

WIDESPREAD interest was manifested in the conference held at the Gibson Hotel, Cincinnati, immediately following the coal convention and exposition under the auspices of the Manufacturers Division of The American Mining Congress.

This conference was called under the joint auspices of the U. S. Bureau of Mines, U. S. Department of Labor, and The American Mining Congress for the purpose of considering:

*First*, the feasibility of a National Mine Safety Code;

*Second*, if feasible, is it worth the effort to make such a code;

*Third*, if both feasible and advisable, what agency shall undertake the working out of such a code?

The meeting was called to order by Dr. Henry Mace Payne, consulting engineer to The American Mining Congress, and the discussion opened by Dean E. A. Holbrook, of Pennsylvania State College, and by Mr. J. F. Callbreath, of The American Mining Congress.

The opening remarks were followed by a general discussion of the subject and the better thought seemed to be that the project was neither feasible nor advisable and that a more general effort should be engaged looking to the prevention of mine accidents.

This was summed up in a statement prepared by a special committee which was unanimously approved as follows:

"The American Mining Congress, because of its years of interest in accident prevention, served as a medium of informal discussion on May 21 of methods for approaching further study of accident prevention.

"That this meeting commends the work of the individual mine operators in taking the initiative in safety work.

"That the collection of information by various agencies concerning safety methods found successful in the experience of mine operators be commended.

"That a comparative study of information on safety methods so assembled and which can further be made available from mine operators be continued by The American Mining Congress."

### "Deliberate Attempt" to Wreck West Virginia Open-Shop Mine

A deliberate attempt made, according to R. M. Lambie, chief of the West Virginian Bureau of Mines, to destroy the open-shop mine of the Virginia and Pittsburgh Coal Company at Kingmont, four miles south of Fairmont, W. Va., failed, early in May, when gas expected to gather in the workings did not form and cause an explosion. Fire did damage estimated at $100,000.

Two fires were discovered burning in the mine by an inspector who went to examine it before he permitted 200 workers to enter. A third fire which had been set had gone out when the inspector arrived at the place. The other two were burning furiously, however.

One of the fires was extinguished after doing considerable damage, while the other was still burning. Chief Lambie, as soon as he received the report of the inspector, sent Bureau of Mines Inspectors Rigeleman and Jarrett to investigate.

Their report, as announced by Chief Lambie:

"The official report of Inspectors Rigeleman and Jarrett is that the mine be on fire, was damaged by a deliberate act of some person or persons unknown. of the Virginia and Pittsburgh Coal Company at Kingmont, W. Va., found to The fact that two fires were found at two widely separated points in the main hallways where there are no electric wires or anything to cause a fire, is, in my opinion, sufficient evidence to indicate that someone executed a carefully worked out plan to deliberately destroy this mine."

### Increased Output of Manufactures Per Worker

The Department of Commerce announces that, according to a study of figures from the censuses of manufactures, the quantity or physical volume of manufactures produced per person engaged in manufacturing increased nearly 50 percent from 1889 to 1925, reflecting a growth of nearly 180 percent in quantity of production and of less than 90 percent in total number of persons engaged.

Expansion in output per person has been particularly large during recent years, amounting to 10 percent in the two years from 1923 to 1925 and to 40 percent in the six years from 1919 to 1925. From 1899 to 1909 there was an increase of 10 percent in production per person, but from 1909 to 1919 the output per person decreased. Comparisons with 1914 and 1921 are affected by the industrial depressions which prevailed in those years, as in times of depression curtailment in production generally exceeds reduction in employment, and therefore output per person is small.

### Boncer Heads Mine Inspectors

At the annual meeting of the Mine Inspectors' Institute of America, May 12, William Boncer, assistant mine inspector of Virginia, was elected president. Other officers elected were: W. H. Jones, Lexington, Ky., first vice president; Nicholas Evans, Johnstown, Pa., second vice president; C. W. Stuart, Thomas, W. Va., third vice president; C. A. McDowell, Pittsburgh, secretary; J. W. Smith, Kansas City, Mo., assistant secretary; Dr. J. J. Rutledge, Baltimore, Md., treasurer; J. T. Beard, Danbury, Conn., editor in chief, and J. H. Edwards, Huntington, W. Va., publicity editor.

### Merger of British Fuel Institutes Reported

The British Institution of Fuel Technology, which was organized in March, 1926, and the Institution of Fuel Economy Engineers, formed in January of that year, have agreed to combine under the title of the Institute of Fuel, and steps necessary to that merger have been taken, according to advices to the Department of Commerce.

Both of the organizations which are to combine were formed for the purpose of giving attention to developments in the more economical use of fuel and allied subjects.

### Buys Coal Tract, Paying $440,000

E. T. Kelley, formerly president and general manager of the Pine Bluff Coal Company, has completed a deal near Brownsville, W. Va., constituting the transfer of more than 100 acres of Pittsburgh coal to the Pittsburgh & Erie Coal Company, at a price approximating $440,000. The property is known as the Bailey tract.

The coal company is now preparing to develop the property, fronting on the Pittsburgh & Lake Erie Railroad. The company also owns a mine, known as the Braznell mine, on adjoining property.

The Robesonia Iron Co. properties near Reading, Pa., have been purchased by Bethlehem Steel Corporation recently. The price paid for the properties, it is reported, was in excess of $1,000,000. This gives Bethlehem iron ore from the old Cornwall ore bank in southern Pennsylvania. The Robesonia Co. has one blast furnace.

Plans are under way for the building of a new mining town at Ritcheyville in Washington County, Pa., by the Vesta Coal Co. of the Jones and Laughlin Steel Corporation. The contracts have been awarded for 200 miners' houses, and the improvements will be conducted on a large scale. The production, however, is not for the open market.

## SHORT COURSE IN COAL MINING AT PENN STATE

**THE Department of Mining of the Bureau of Mines and Metallurgy of the Pennsylvania State College is offering a five weeks' summer course in practical coal mining, from June 20, 1927, to July 23, 1927. This course is open to all men about coal mines, bituminous or anthracite. The State Department of Mines has announced that examinations will be held for bituminous mine foreman and fire bosses at State College July 20, 21 and 22, at the close of this course. Further information may be obtained by writing E. A. Holbrook, Dean, The School of Mines and Metallurgy, State College, Pa.**

### Standardization in Sweden

An association for the furtherance of standardization work has been formed in Finland as a result of concerted action of three central organizations in the Finnish field of production and representatives of the business interests of that country, according to advices to the Department of Commerce.

The announced purpose of the new organization is to provide economic support and other means for the development of standardization in the productive enterprises of Finland.

A tract of 720 acres of coal land in Huntington Canyon, Utah, has been leased to W. I. Snyder by the local land office. The conditions of the lease require that there shall be a minimum investment of $100,000 for the first three years, and that the minimum production at the end of the fourth year shall be 60,000 tons. The Government royalty is 10 cents a ton.

"The average pay of Union Pacific Coal Company miners in the Rock Springs, Wyo., district will be greater this year than it was last," said Eugene McAuliffe, president of the company, recently. The average was $142.99 in January, $115.19 in February, and $144.46 in March, according to Mr. McAuliffe. The average monthly pay for the year 1926 was $163.76, although the February and March average was less than the 1927 for the same months. The spring months constitute the lean period as a rule for the local coal industry, and McAuliffe predicts that the ensuing months of this year will be correspondingly better, so that the yearly average pay will show a good increase. Last year the miners of the district received an average of $1,965.12 for 182.2 days worked.

Work has been started, totaling more than $100,000, on improvements to be made at five Huerfano County coal-mining properties at the Robinson No. 1 mine, Walsen, Colo., by engineers of the Colorado Fuel & Iron Co. Proposed improvements include changes in underground workings and mine buildings, construction of garages, boarding houses and 25 residences. It also is planned to plant trees and shrubbery to beautify the properties. The plants to be improved are Walsen, Cameron, Tioga, Ideal and Pictou.

The Superior-Rock Springs Coal Co. and the Premier Coal Co., operating at Superior, Wyo., valued at more than $1,000,000, have been virtually merged through the organization of the Ideal Coal Co. The new corporation is composed of officers of the other companies and it will handle operations and sales for both.

Workings of the Sandy Run Coal Company, Philadelphia, Pa., which were abandoned during the anthracite strike of 1902 and permitted to fill with water, are to be reopened by the company. Three shifts of men will be put to work when pumping out the water and cleaning up the slope in readiness for operations.

The Benoit Coal Company is planning to sink a new slope at Benoit, near Dora, Walker County, Ala., where a number of drifts are now operating on the Mt. Carmel coal seam. Quite a lot of new trackage will be necessary to connect this new opening with the tipple and washery serving the drifts, which will also handle the output from the new mine. C. S. Bissell, Age-Herald Building, Birmingham, is president of the company.

An eight-mile drainage system in the Indian Creek Valley Coal field, intended to divert acid-laden water from the large mines in the valley around the reservoir of the Mountain Water Supply Company, Pittsburgh, Pa., will soon be completed. The system embraces 1,800 feet of tunnels, 14,000 feet of wooden flume and the remainder of open ditch. The mine water is to be turned into the system about June 1.

The Vesta Coal Co., a subsidiary of the Jones & Laughlin Steel Co., will in the near future begin construction of the first railroad car ferry in the Pittsburgh district. Two barges are to be used between Woodlawn on the Ohio River, where the steel plant is located, and the Vesta mines on the Monongahela River. One barge will be at the disposal of each terminal. These barges will be taken loaded with railroad cars by the company steamers and delivered at destination.

# GREAT DISPLAY MINE EQUIPMENT AT NATIONAL EXPOSITION

*Exhibits Show Great Diversity—Mechanical Loading And Coal Preparation Equipment Attract Much Attention—Equipment Entering Every Phase Of Operation Shown From Shovels To Sub-Stations; From Timber Treating Plants To Frogs*

THE greatest Exposition of Mining Equipment ever assembled was held in conjunction with the Fourth Annual Convention of Practical Coal Operating Men, Cincinnati, Ohio, May 16 to 20. By far it was the largest exhibition of this type of equipment ever held in the world. Everything entering into coal production was upon exhibit, the whole being an extremely interesting, up-to-date and instructive visualization of the methods of coal production. Taken in conjunction with the program for the convention, it constituted a real course in mining engineering and production that has never been surpassed.

There were one hundred and seventeen exhibitors, occupying 33,435 square feet of floor space, the value of the exhibits running into millions of dollars.

It would be quite impossible to give a detailed description of each exhibit, but the following brief resume will indicate the great diversity, the wide range of application to production problems, and the completeness of the exposition:

**Ahlberg Bearing Co.**

This exhibit consisted of a complete display of the CJB Master ball bearings, showing bearings in process of manufacture, together with the completed material. Also a complete line of Ahlberg Ground Bearings, showing the process of reclamation.

**Allen and Garcia**

Operating model of screening equipment for a five-track tipple. Improved skip and skip loading equipment—loading accomplished by the use of gate and without measuring pocket. Model of steel cars equipped with the semi-automatic couplers.

**Allis Chalmers Mfg. Co.—Automatic Reclosing Circuit Breaker Co.—Cutler-Hammer Manufacturing Co.**

Complete automatic sub-station, consisting of 150 KW., 1,200 r. p. m., 2,200 volts A. C. to 250 volts D. C. Synchronous motor generator set built by Allis-Chalmers Manufacturing Co., with automatic control furnished by Cutler-Hammer Manufacturing Co., and the Automatic Reclosing Circuit Breaker Co.

**The American Car and Foundry Co.**

Exhibit consisted of one all-steel drop bottom mine car built like a drop bottom freight car. One all-steel Saw Tooth Bottom mine car for an end gate dump, designed to utilize all the allowable space between the rails, forming a construction of a type of low car of greatest possible capacity. Also a number of mine car wheels of different types.

**American Cast Iron Pipe Co.**

Cast iron pipe; tar dipped for average mine water; cement-lined for highly acidulous water. Small diameters 2, 3 and 4 in.

**American Coal Cleaning Corporation**

Diagrams of their pneumatic coal cleaning process and large photographs of the O'Toole cutting and loading machine.

The American Pneumatic Coal Separator, Full "Y" Type, was displayed in the tent in front of the hall.

**The American Mine Door Co.**

Showed a line of electrical devices and line material consisting of trolley clamps, tu-wire clamps, trolley splicers, trolley frogs, cable splicers, terminals for welding and compressed bond, terminals for resistance grids, etc. Their main display was a demonstration of a relay switch with control and release, for operating a system of automatic flagging or signals, which are used independently or in connection with their Automatic Mine Doors and Automatic Switch Throwers.

**American Rheolaveur Corporation**

Working models of the Rheolaveur cleaning process with an experimental Rheolaveur plant of the free discharge type. This plant washes a mixture of white sand and bituminous coal, these two materials being used on account of their difference in color. The refuse was represented by the sand and the washed product, of course, by the coal.

This plant is an exact replica of a larger size Rheolaveur plant and has a capacity of about 1 to 1½ tons of feed material per hour.

In addition to this plant, they exhibited a small sealed discharge Rheo Box operating and a sample of wedge wire screen; also a drawing of the new Carpenter coal drier.

**American Steel and Wire Co.**

Electrical wires and cables of all kinds for mines. Rubber covered wire and cable, mining machine cables, wire strand, telephone wire, cords and rail bonds.

**American Wood Impregnation Corporation**

Specimens comparing condition of samples of untreated wood and wood treated with Wolman salts after exposure to many different destructive conditions such as mine water, fire, weathering, ants, etc.

**Ames Shovel and Tool Co.**

Shovels for mine and industrial uses.

**Atlas Powder Co.**

Shot firing apparatus outfits and dummy cartridges of explosives and all kinds of literature on blasting.

**Automatic Reclosing Circuit Breaker Co.**

This exhibit was arranged in conjunction with the displays of Allis Chalmers Mfg. Co., and Cutler-Hammer Mfg. Co., and is described under the heading of Allis Chalmers Mfg. Co.

**Baldwin Locomotive Co.**

The Baldwin-Westinghouse mine locomotives exhibited represented the most modern trends in the development of haulage and gathering types of motive power, respectively. The four-ton gathering locomotive is the lowest and slowest of this type ever built and meets the demand for motive power for working thin seams, having an overall height of 23 5/16 in. and speeds of 2¼ miles an hour when operating from conductor cable and 6 miles an hour when operating from the trolley. Some of the features of its design include semi-magnetic control, barsteel frames, self-equalizing coil springs, spacious accommodations for motorman, ball bearing motors, vertical type cable reel, new type resistor and other standard practices embodied in the construction of Baldwin-Westinghouse mine locomotives.

**Bethlehem Steel Co.**

Exhibited the following products: Model 1217, Model 75 and No. 4 switch stands; Bethco rail anchors; Grimm rail clamps; steel mine ties; manganese frogs; coupling links; gage rods; rail braces, and a light switch rigged up for operation.

Bethlehem standard mine ties and the Model 75 switch stand were especially featured. Each of these products was displayed in a shadow box and the moving parts of the tie and stand were in operation.

Besides being shown under the bright lights of a shadow box, the Model 75 stand and the adjacent half of a light switch was mounted on steel mine ties. The stand and switch point was arranged so as to be operated just as in service.

Bethlehem mine and industrial track equipment was awarded a Gold Medal at the Sesqui-Centennial International Exposition and the certificate of award was also on display.

**Boxill-Bruel Carbon Co.**

Exhibit was devoted chiefly to educational propaganda, showing a machine used for determining the characteristics of brushes. They also exhibited the evolution of brushes from the rough material in the powdered form to the finished brush which is ready for use on machines.

**The Brown-Fayro Co.**

Exhibit consisted of their Model HG room hoist, which is an enclosed model and adapted for easy skidding about the mine. The "Brownie" hoist with variable speed control and special guard features preventing the rope from becoming fouled. Dimensions of the "Brownie" hoist (overall) 45 in. long, 23 in. high, 28 in. wide; weight with standard motor, 1,125 pounds. Their "Brownie" car retarder was also an important feature of the exhibit.

**The Chance Coal Cleaner**

Exhibited an operating model of the Chance Sand Flotation plants. This model is designed for continuous operation and will prepare anthracite of pea size and smaller at the rate of about one ton per hour. The model is approximately 3 ft. wide, 6 ft. high, and 8 ft. long.

**Chicago Pneumatic Tool Co.**

Various types of electric drills including permissible coal drill, open type electric drill, air drill, pneumatic rock drill and pneumatic riveting hammer. Carbon dioxide gas cartridge.

**Cincinnati Ball Crank Co.**

Lubricators, cables and gears.

**Cincinnati Steel Castings Co.**

Castings for mining machines, mine cars and miscellaneous castings for use in mine cars and locomotives, pinions for machines of all descriptions, mine car wheels. Extension rail clamp of high alloy steel used to give track to the face in a few minutes.

**Coal Mine Equipment Co.**

Scranton pump, centrifugal triplex plunger pump, all-bronze piston pump, Malady automatic electric safety gate hoist.

**Burton Publishing Co.**

Coal Mine Management.

**The Coloder Co.**

The feature of the Coloder exhibit at Cincinnati was the showing of an operating model of a new Coloder type.

The company showed an operating model of their Type H, a Coloder operating on the frontal attack principle. Previous Coloder types have used a side gathering chain which is most efficient where wide places are to be loaded from a track mounting. The Type H is specially adapted for loading in places from 9 to 18 ft. wide. It has an underhand digging and conveying device composed of staggered flights on a multiple chain conveyor. The Type H Coloder is mounted on a four-wheeled truck and stays on the track. The gathering conveyor and the car loading conveyor each swing through an arc of 90 degrees. This Coloder is operated and controlled by one man. It loads slate or coal with equal efficiency.

**Concordia Electric Co.**

"CEAG" Electric Safety Cap Lamp, U. S. Bureau of Mines' Approval No. 21. The lamp produces the high amount of illuminating power, properly maintained over an 18-hour shift, the brilliancy of light being the same at the end of the shift as at the beginning. "CEAG" Electric Safety Trip Lamp, U. S. Bureau of Mines' Approval No. 1000, the only trip lamp tested and approved by the U. S. Bureau of Mines, also employing a dry-electrolyte battery. "CEAG" Shotfirer with dry-electrolyte-battery, U. S. Bureau of Mines' Approval No. 1204. Gas Detector employing a catalytic body and a screen device, indicating the presence of methane gas as low as 1½ percent; Conveyor Lamp; Official Lamp; Inspector Lamp; charging racks, and lamphouse equipment.

**Conveyor Sales Co.**

Display of Eickhoff M T A 15 shaker conveyor drive and also one ball bearing shaking conveyor supports. F. N. A. coal pick hammers.

**Cutler-Hammer Mfg. Co.**

This exhibit was a part of the joint exhibits of Allis Chalmers Mfg. Co., Automatic Reclosing Circuit Breaker Co., and Cutler-Hammer Mfg. Co., described under the Allis Chalmers Mfg. Co., heading.

**Deister Concentrator Co.**

The Leahy Vibrating Screen and photographs. This screen is used for coal preparation.

**Dravo Doyle Co.**

Austin worm driven pump. Austin 5 by 6 flame proof pump. DeLaval speed reducer for conveyor work. Rodgers feeder clamp.

**The Deming Co.**

Deming mine gathering pump, which was in operation. This pump equipped with glass cover plates over suction and discharge valves to show action while pump is in operation. Deming mine gathering pump cut open to show internal mechanism. Deming grease gun for mine car wheels.

**The Duff Manufacturing Co.**

Exhibited Barrett mining jacks; Barrett single acting automatic lowering jacks; Barrett single and double acting track jacks; Barrett general purpose jacks; Duff governor controlled high speed ball bearing screw jacks; Duff ball bearing screw jacks for general purposes; timber braces; the Duff pinion puller, and Duff ball bearing journal box jacks.

BETHLEHEM
Bethlehem Steel Company
SKF
Carnegie Steel Company
American Steel & Wire Co.

**E. I. du Pont de Nemours & Co., Inc.**

This consisted of an electric flasher display applying to Pellet Powder—a new coal mining explosive.

The display consisted of a series of flashes, showing in red and green, indicative of the danger and safety factors associated with the use of explosives in coal mining. The display was partially surrounded with appropriate draperies, and the illumination was controlled by electric switches in the usual flash-light manner. There was also displayed a mammoth cartridge representing Monobel No. 10 permissible explosive. Also an exhibit of a chart indicating the consumption of Pellet Powder in the coal fields since its introduction to the present date.

**Eagle Iron Works**

Working model of Olson self dumping cage, together with photographs and literature. Also descriptive matter on roller bearing car wheels and trucks.

**Edison Storage Battery Co.**

Cells, with cans partially cut to show inside construction. Tray of 5A-8's cells as used in mine locomotives. Display board upon which the various parts of the Edison Batteries were mounted. Edison Batteries (complete). Mine lamp. Electrical filling outfit, and an oil painting of Mr. Thomas Edison.

**The Electric Railway Equipment Co.**

Exhibit consisted of a complete display of standard overhead trolley line material as well as about fifteen new devices for supporting both trolley and feeder wires from one insulated trolley suspension.

**Electric Railway Improvement Co.**

Welding equipment and rail bonds.

**Electric Storage Battery Co.**

Batteries for mine locomotives. The famous Exide Iron Clad Batteries.

**Enterprise Wheel and Car Corporation**

Display of two mine cars.

**Eureka Copper Products Corporation**

Exhibit was made up of renewal parts of electrical equipment used in the iron and steel industry.

These parts consist of complete commutators, assemblies, and commutator bars; brush holders of various types; controller fingers, segments, contact tips, field plates, etc.; trolley wheels; cable connectors; copper leaf and gauze brushes; copper nuts, and similar parts.

**The Explosives Engineer**

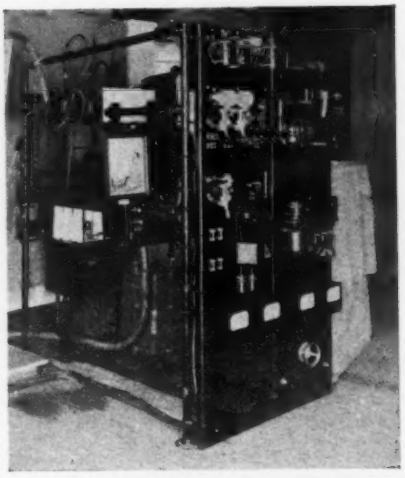
Copies of the publication.

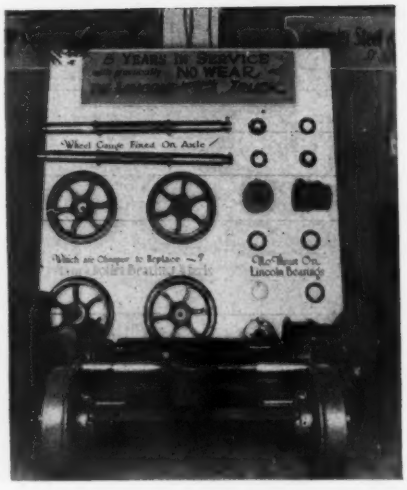
**Fairbanks, Morse & Co., Inc.**

A sectioned squirrel-cage motor running on a little air. Direct-current motor. Type H ball-bearing motor. High head, high speed centrifugal pump in operation. 5 by 6 mine gathering pump. A moderate head ball-bearing centrifugal pump. Dial scale for use in mining service. Portable dial scale to demonstrate the weighing on a Fairbanks scale. They also displayed some Diesel engine installation and products views on the back wall.

**Fort Pitt Mine Equipment Co.**

The exhibit of the Fort Pitt Mine Equipment Co. consisted of blueprints, photographs and literature, descriptive of the various devices manufactured by this company. These devices are all intended to control the movement of mine cars. They consist of cushioned horn stops, automatic gravity feeders or cages, automatic stopping, locking and releasing mechanism, for use on mine cages, and self-dumping mine cages equipped with automatic stopping, locking and releasing mechanism.






**Frederick Iron & Steel Co.**

Working model of coal separator and centrifugal pump.

**General Electric Co.**

Thirteen-ton locomotive trolley pole type. Line material. Permissible motors, mine sectionalizing equipment and automatic station, the sub-station in operation.

**Goodman Manufacturing Co.**

Display of Type 319 Goodman shearing machine. Large photographs of other equipment.

**Grasselli Powder Co.**

Display of the ingredients of various explosives and dummies of cartridges.

**Heisler Locomotive Works**

Working model, 55-ton Heisler locomotive, built to 1/10th scale. These locomotives are used in open pit mines and for outside haulage and switching around deep mines.

**Hendrick Manufacturing Co.**

Perforated metal screens. Elevator buckets. "Mitco" interlocked steel grating. "Mitco" Shur-Site stair treads. Milled slot screen plates. Flanged lip screens.

**Hercules Powder Co.**

The permissible explosives shown in the Hercules exhibit are the result of an effort on the part of the Hercules Powder Co. to produce a simplified list of permissible explosives, one of which will shoot almost any kind of coal in the form desired. Hercules brands of permissible explosives embrace the three general types known as ammonium nitrate type, nitroglycerin type, and the gelatin type.

One of the features of the Hercules exhibit was the two motion picture films, one entitled "Hercules Blasting Caps," showing the manufacture and testing of blasting caps, and the other film entitled, "The Explosives Engineer—Forerunner of Progress," showing many industrial uses of modern explosives.

**Hockensmith Wheel and Mine Car Co.**

Improved Hockensmith-Timken mine car wheel. They also displayed special draft gear for large and medium capacity cars and sheaves and rollers, Timken and Hyatt equipped.

**Hulburt Oil and Grease Co.**

Display of the grease drums.

**Hyatt Roller Bearing Co.**

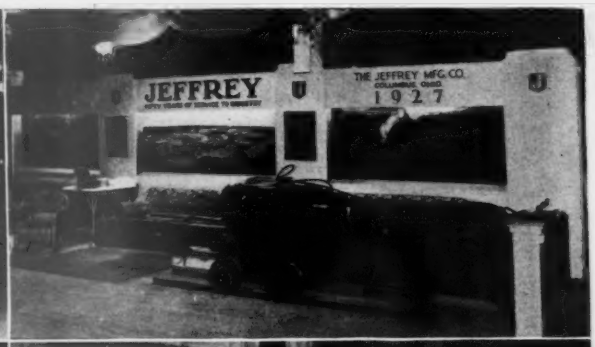
An interesting parallel was drawn between the service encountered by bearings in mine and railroad rolling stock at the Hyatt Roller Bearing Co. display, where the Hyatt railway journal box was exhibited. At the Hyatt booth other allied applications were shown, such as conveyor idlers, pillow blocks, line shaft bearings, etc.

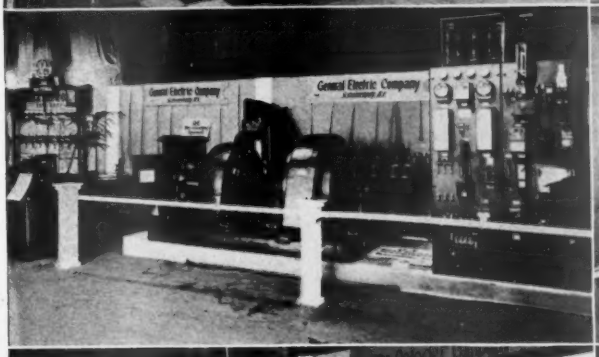
**Hydrotator Co.**

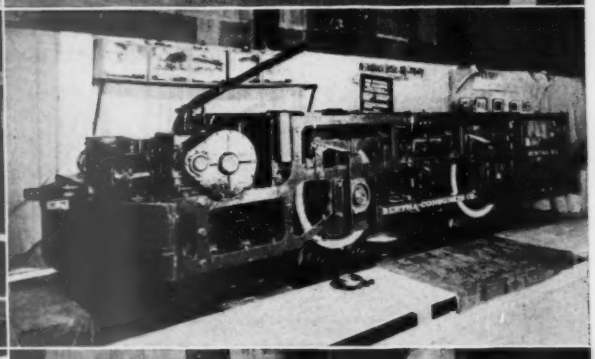
The Hydrotator—for the purpose of cleaning small sizes of coal from ½-in. down to dust. The coal is separated from the slate by a rising current of water separating the coal from the refuse by a specific gravity separation. There are several plants working in the anthracite region and there will shortly be several working in the bituminous coal region. This is a new device just being put on market.

**Ironton Engine Co.**

The purpose of this exhibit was to show the operator the advantages of worm gear drive using the English type gear which are now made in this country by the Cleveland Worm Gear Co. and the Timken Roller Bearing Co., exclusively. The efficiency of this type of gear runs very high, from 90 percent to 96 percent and is free coasting. Large


JEFFREY
THE JEFFREY MFG. CO.
COLUMBUS, OHIO
1927


General Electric Company



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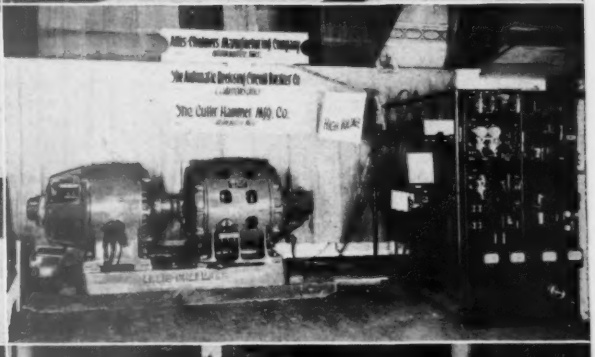
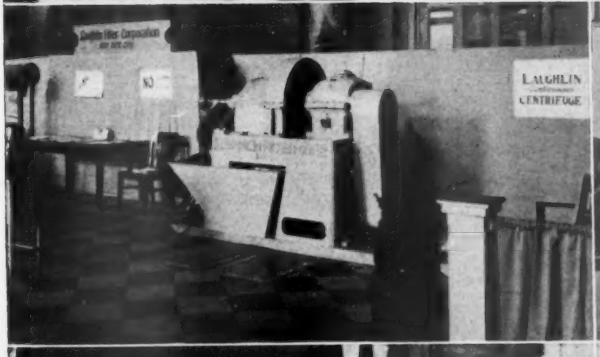

The Cutler Hammer Mfg. Co.


LAUGHLIN
CENTRIFUGE

Union Carbide and Carbon
DEMONSTRATION

photographs of the Ironton engine on display.

**The Jeffrey Manufacturing Co.**

1927 is the fiftieth anniversary of this company. They prepared three paintings. One of these depicted the primitive method of mining in vogue in 1877 at the time the first Jeffrey cutter was introduced. Along with this picture was exhibited the model of the first Jeffrey coal cutter. Another picture depicted the up-to-date method of coal mining with a Jeffrey 35-B coal cutter and along with this was exhibited a Jeffrey 35-B coal cutter on its Handitruck.

**Joy Manufacturing Co.**

Improved type, permissible, 5 BU Joy Loader in actual demonstration in coal. The loader operated in the tent in front of the Exposition Hall and commanded a great deal of attention.

**The Joyce-Cridland Co.**

A complete line of jacks for all classes of mine service, from the small 2-ton jack for handling track up through the different styles of jacks for handling machinery to the big heavy duty jacks for handling loaded cars and for rigging purposes.

**Keystone Lubricating Co.**

Complete line of oils and greases, automatic lubricating systems. Systems for mine car wheels and other machinery.

**Edw. C. Kirk & Sons**

Exhibited the Edw. C. Kirk Air Cooled Sand Drier, designed to thoroughly dry sand without burning it. The cooling system eliminates the possibility of the cast iron melting or burning. Cooling is accomplished by means of a smoke-stack suction, forcing cooled air into all heated parts. The E. C. K. drier provides 4,032 more square inches of heating and sand drying surface than any other round stove type drier.

**Koehler Manufacturing Co.**

This company and their distributors, the Portable Lamp & Equipment Co., exhibited a complete line of miners safety lamps, including the Super Wheat Electric Cap Lamp, approved by the United States Bureau of Mines and the Koehler Flame Safety Lamp, together with necessary charging apparatus in the way of rectifiers, rheostats, etc., for the proper operation of these lamps.

**The La Bour Co.**

Exhibited several automatic gathering valves operating in glass cases and at different levels to demonstrate the use of these valves for automatic sump drainage. Valves operate in conjunction with a La Bour centrifugal gathering pump fitted with a partial glass suction line to show the ability of the pump to handle air. An open pump and valve was displayed so that parts could be examined and operation of pump and valve explained.

**Laughlin Filter Corporation.**

Demonstration of Laughlin continuous centrifuge dewatering fine coal sludges.

**A. Leschen & Sons Rope Co.**

Exhibit consisted of a miniature aerial tramway modeled after actual installation now operating in West Virginia. This miniature tramway was in operation. Exhibit also contained samples of the various kinds of wire rope.

**Lincoln Steel & Forge Co.**

Type E pneumatic grease machine air operated for mine cars. Lincoln self-aligning journal box trucks for mine cars.

**Link-Belt Co.**

The first showing of the Kangaroo Conveyor (Real Kangaroo as trademark). A new type of rubber covered idler and a new type cromium plated idler were shown for the first time in The American Mining Congress show. Photographs representing practically the entire Link-Belt line shown around the booth. Samples of Link-Belt chains used in the coal mining industry were shown.

**The Lorain Steel Co.**

Sectional conveyor. Portable belt face conveyors. Mine jacks. Steel mine car.

**C. H. McCullough Engineering Co.**

Exhibits of drive and ball bearing equipment of the Mavor & Coulson Shaker Conveyor. Booth inside and equipment in tent.

**McGraw-Hill Catalog and Directory Co., Inc.**

Publications and service of above company.

**Mancha Storage Battery Co.**

New permissible mine locomotive exclusive for gaseous mines. Photographs.

**The Martindale Electric Co.**

Exhibited their main products consisting of the Imperial undercutter, the Martindale armature slot cleaning outfit, Imperial commutator stones, Imperial commutator grinding tools and Martindale insulation meter.

Their new 36-page catalog containing an interesting carbon brush maintenance and trouble chart and describing their complete line of motor maintenance equipment was distributed.

**Mine Safety Appliances Co.**

In addition to their well-known line of safety appliances, including Edison Electric safety Cap Lamps for miners, together with self-contained Oxygen Breathing Apparatus (Gibbs, McCaa Half-Hour and McCaa Two-Hour), the Self Rescuer, the Burrell All-Service Gas Mask, first aid equipment and supplies, the Continuous Methane Recorder, etc. This company offered three novel features for this year's exhibit. These new features are the M-S-A Adjustable Roof Supports for coal mine entries and gangways 8 ft. to 14 ft. wide; the new M-S-A Mine Fire Fighting Truck (La France type), mounted on ball bearing wheels, with complete equipment including masks, etc., for five men; and the new M-S-A Rock Dust Distributor. The latter was shown in the tent in front of the entrance to the Exhibition Hall.

**The Mining Congress Journal.**

Publications of The American Mining Congress.

**Mining Safety Device Co.**

Working models of new Nolan Automatic Safety Bumper Stop Feeder. Also models of horn feeders and full size model of the bumper used on the bumper stop feeder.

**Modern Mining**

Copies of the publication.

**Morgan-Gardner Electric Co.**

Exhibited their Mine Scooter together with a few parts for the mining machines.

**Morrow Manufacturing Co.**

Working model of standard self-feeding shaker screens for coal. Standard self-feeding revolving screen for the preparation of sand and gravel. Various types of perforated plate consisting of standard round-hole perforations, also lip screens.

**Mosebach Electric Co.**

Arc weld rail bonds, brass and bronze bearings for locomotive and mining machines, drum line material, flat coil testing machine, extension bolts, mine section insulator switches.

**Murray Pump & Valve Manufacturing Co.**

"Everlasting" pumps and pipe line valves. Murray wood foot valve and strainer, also standard acid resisting bronze pumps. The Safety Electric Sander.

**Myers-Whaley Co.**

Exhibited in the tent at the front of the Exposition Building a Permissible No. 4 Size Myers-Whaley Shovel. This machine is equipped with electric motor and control equipment that has been approved by the United States Bureau of Mines for use in gaseous mines, and was shown in operation under its own power. In their booth the company showed a complete set of photographs, literature and a model in operation, illustrating the automatic shovel motion used on Myers-Whaley machines.

**National Carbon Co., Inc., and Union Carbide Co.**

These companies exhibited a complete line of carbon graphite and metal graphite brushes for electrical machinery. The exhibit also consisted of welding carbon specialties and other carbon products of interest to the mining industry; methane detector, permissible shot-firing device, permissible focusing flashlight; stellite, an alloy for shovel tips, frog points and other points of mine machinery, used for its wear resisting properties; Oxy-acetylene welding outfits, Linde Air products (oxygen and other gases), Prest-O-Lite gas, National Carbide for mine lighting, portable carbide hand lamp.

**R. D. Nuttall Co.**

Speed reducer for double and single reduction and gearing for mine locomotives and mining machines. Photographic display of manufacturing of gears.

**Ohio Brass Co.**

Entire line of overhead equipment, head lights, insulators and rail bond.

**The Osborne Register Co.**

Scrip issuing and recording register, used in conjunction with patented metal scrip as a credit system by commercial operating industries. Three registers and metal scrip exhibited.

**Pennsylvania Crusher Co.**

Model of Pennsylvania Bradford breaker, used extensively for by-product coke and in power plants and coal mines for crushing and cleaning coal in one simple operation, also model of large single armor frame Pennsylvania crusher. Display of photographs of installations of this equipment at various plants.

**Penn Machine Co.**

Repeat parts for mining machines, rail bonds, gears and pinions.

**Phillips Mine and Mill Supply Co.**

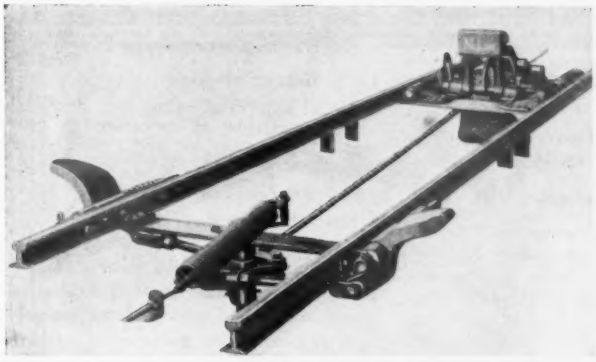
Phillips-Barkley gravity rotor dump displayed in small working model. Phillips cross-over dump. Open cap trucks. Gravity screens and screen bars and models of tipple chutes.

**Post Glover Electric Co.**

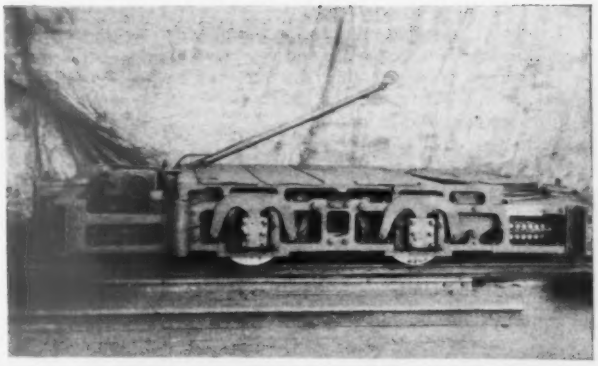
Steel resistance for controlling current of electric locomotives and starters.

**Princeton Foundry & Supply Co.**

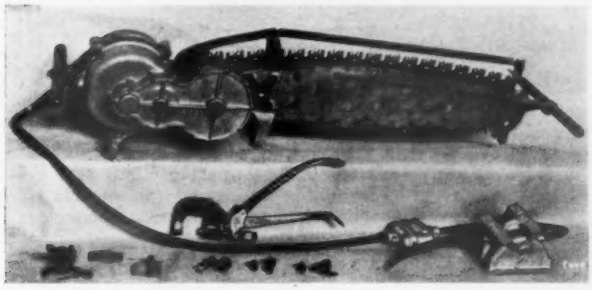
Exhibited the Perfection Cone Stove Sand Drier, having five cones above the fire box, admitting the moisture of damp sand into smoke pipe instead of being forced out through sand, this being considered an improvement over the old type stove driers.



*Nolan Automatic Safety Bumper Stop Feeder*

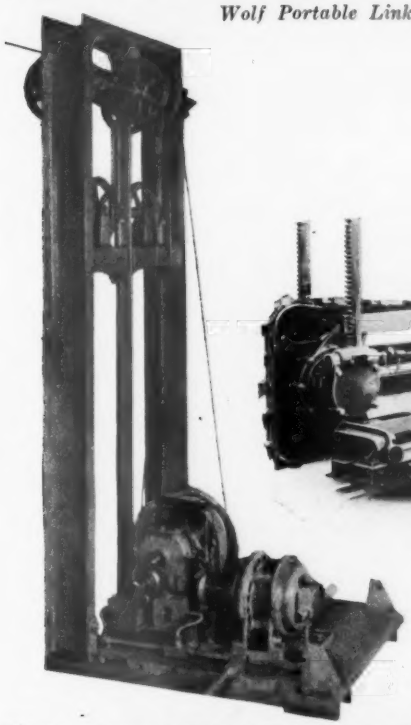


*Westinghouse-Baldwin 4-ton Gathering Locomotive*

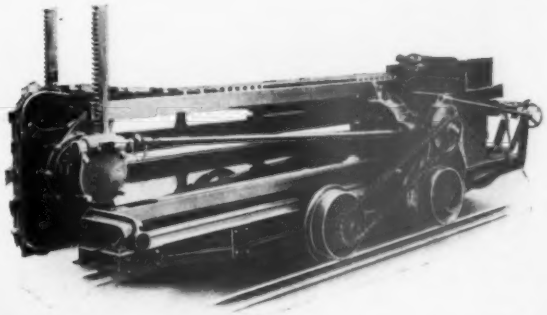


*Wolf Portable Link Sawing Machine*

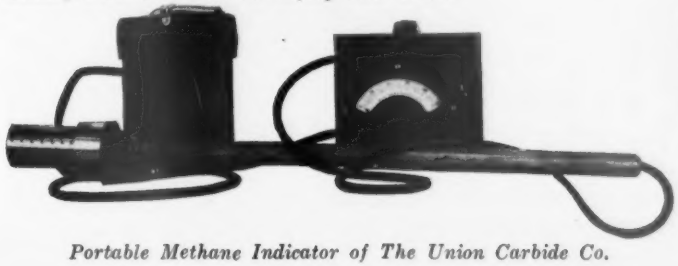
*M. S. A. Adjustable Roof Supports*



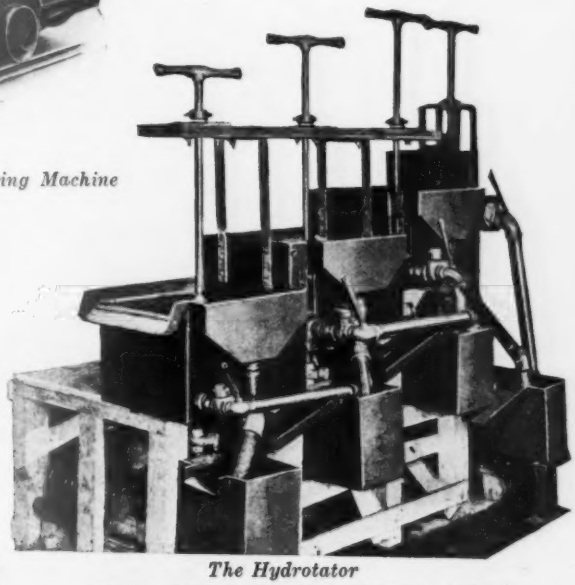
*Malady Automatic Electric Safety Gate Hoist*



*Type 319 Goodman Shearing Machine*



*Portable Methane Indicator of The Union Carbide Co.*



*The Hydrotator*

**NEW EQUIPMENT SHOWN AT THE CINCINNATI EXPOSITION**

**Reed-Prentice Corporation.**

Exhibited the No. 1 Wolf Portable Link Sawing Machine. An entirely new development of a portable sawing machine for the cutting of the great quantity of timber used in mines.

**Roberts & Schaefer Co.**

This exhibit consisted of a complete line of photographs of plants, tipples and pneumatic coal cleaning equipment, recently designed and installed by them. They also had available full information concerning the Arms Table and other special features of their dry cleaning process.

**Robinson Ventilating Co.**

The display consisted of the model of the reversible mine fan for primary ventilation of coal and metal mines. Also the actual blower in operation to be used with canvas tubing for auxiliary ventilation and removing smoke after the coal is blasted. Also a disc fan for temporary ventilation during new development. A model of a man cooling van which is used in power houses and hoisting rooms.

**John A. Roebling & Sons Co.**

Display cases showing wire rope, rope fittings, wire cloth, insulated wire in all sizes and kinds.

**Rome Wire Co.**

"Super-Service" cords and cables for mining and other heavy duty uses; also heavy cables for electrically operated shovels for strip operations. Demonstration of resistance of cable to pounding and bending tests.

**Sanford-Day Iron Works, Inc.**

The exhibit consisted of a model mine with cars running from drift and slope dumping over one tipple. Two full-size mine cars, one of the Automatic Drop Bottom design and one of the Whopper design. An electric power high pressure grease gun. Roller bearing wheels and trucks.

**Simons Paint Spray Brush Co.**

Exhibit comprised spray brush, and electric portable air compressor.

**Simplex Wire and Cable Co.**

Samples of Tirex Portable cords and cables.

**S. K. F. Industries.**

Arch display of Claude Neon sign, large S. K. F. Spherical bearings used on railroad journal applications and heavy mining equipment, also a full line of single and double row deep groove ball bearings as well as double row self-aligning S. K. F. bearings showing mine appliances covering both metal and coal mining Skayef line shafting equipment.

**Streeter-Amet Weighing and Recording Co.**

Exhibit consisted of an automatic mine tipple weight indicating and recording attachment.

**Sullivan Machine Co.**

Photographs of their modern coal cutting equipment, diamond core prospecting drills, cutter bit sharpening machines, air compressors, etc.

**Taylor-Wharton Iron and Steel Co.**

Exhibited elevator chain, steam shovel dipper teeth, sprockets and sheave wheels, seamless steel roller and manganese mine frogs.

**Templeton, Kenly & Co.**

Jacks for use in mine operations, also a new type timbering jack and post pulling jack.

**The Timken Roller Bearing Co.**

Two features of particular interest were, first, a tapered roller bearing for railroad service, of the type recently installed by the Chicago, Milwaukee & St. Paul Railroad on their two famous trains; and second, a steel mill roll neck bearing such as has been developed for, and successfully applied to, both cold roll and structural mills. The dimensions of the bearing exhibited are: 17-in. bore and 27 in. outside diameter. Several bearings of this type have been installed and are operating successfully in some of the largest steel mills in the country.

**Tool Steel Gear & Pinion Co.**

Exhibit consisted of gears, pinions, sprockets, rollers, bushings, rings for mine locomotives and mine machines, also speed reducers for all kinds of mine and industrial business, all made of the specially hardened and toughened Tool Steel quality.

**Bertrand P. Tracy Co.**

Demonstrated the "Tracy Koalveyor" and entry conveyor for the delivery of coal from the working face to mine cars located on the entry. The "Koalveyor" is built in lengths up to 250 ft. It is adaptable to both hand and mechanical loading and designed to increase the efficiency of hand loading from 200 to 300 percent.

**Traylor Vibrator Co.**

Vibrating screen operating and electric mine signals.

**Troco Lubricating Co.**

Exhibit consisted of three empty drums, labeled with Troco Safety Grease labels, and samples of liquid greases and solid greases for the lubrication of mining equipment.

**The W. S. Tyler Co.**

Exhibit included a Hum-mer electric screen, a Ro-Tap testing sieve shaker, and a Delatester.

**Una Welding and Bonding Co.**

UNA copper weld bonds for all classes of mine service. Ajax welders for welding and bonding applications. UNA welders for shops. Electrodes—copper and steel for all requirements.

**Union Carbide Co.**

See National Carbon Co., Inc.

**U. S. Bureau of Mines.**

Model exhibit showing rock dusting of mines, methods of detection of gases, methods of protection and general safety equipment.

**The Watt Car and Wheel Co.**

Exhibit consisted of an up-to-date composite mine car, for use in the rotary dump, and life-size models of Watt-Timken wheels and Watt-Hyatt wheels. There was also a demonstration of a trolley guard, the purpose of which is to guard the trolley wire in the mines to safeguard the workmen's lives, as well as animals' lives, should animal haulage be used. This trolley wire guard is a patented article.

**Waverly Oil Works.**

Display of oil, grease and soap.

**Weinman Pump Manufacturing Co.**

One mine gathering pump with visible self-oiling device and line strainer. Centrifugal pump with special Weinco acid-resisting metal.

**Weir Kilby Corporation.**

Light Rail Titan mine turnout complete with modern stands and Karr patented boltless, non-rusting spring splice bar.

**Westinghouse Elec. & Manufacturing Co.**

Exhibited a 20-ton haulage locomotive, the first of its type and the most powerful locomotive ever built, having two 150-horsepower motors, also a 4-ton gathering locomotive which is the lowest and slowest of this type ever built, designed for working thin seams. Their exhibit included also a demonstration of mine locomotive headlights built to withstand severe operating jar; automatic substation equipment; and new line material, type M resistor, improved compensating fingers, the archi mine clamp, twin washer type brushholder mechanism, type SL splicer, double gap section insulator and overlapping runner trolley frog; designs of switches in the various standard lines, panel-board construction, two-pole switches.

**The West Virginia Rail Co.**

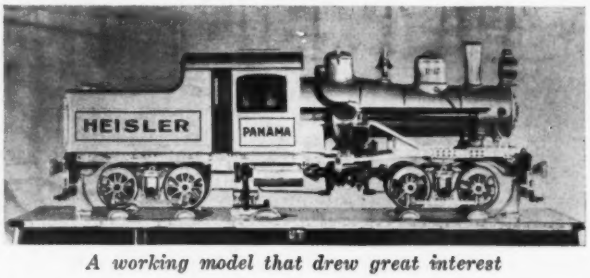
Complete steel turnout ready for installation. Section of light track equipped with various types of mine ties. Section of heavy track equipped with various types of main line ties. Complete switch equipped with W. Va. patented kick switch plates. Riveted type and cast type of frogs. Rail Steel Concrete reinforcing bars. Various type of switch stands. Complete line of A. S. C. E. section light rails.

**Willison Automatic Mine Car Co.**

Naco swivel and plain link hitchings, special heat-treated steel.

**Max Wocher & Son Co.**

First Aid supplies, hospital equipment and fractural appliances.




*A working model that drew great interest*

"Build to Endure"

# WOLMANIZED LUMBER

*All Kinds of Wood Products Treated with*
*WOLMAN SALTS*

ENDURING PROTECTION Against Decay—Reduces Fire Hazard—Does Not Exude or Affect Metal Fastenings—May be Painted or Stained—Standard Practice in Central Europe for Twenty Years

*We Specialize in WOLMANIZED Mine Props, Lagging, Mine Ties, Shaft Timbers and for all Structural Purposes*

**AMERICAN LUMBER & TREATING CORPORATION**
**1138 LAKE SHORE DRIVE**
**CHICAGO**

# BUYER'S DIRECTORY

**ACETYLENE, Dissolved (Or in Cylinders)**
Prest-O-Lite Co., Inc., 30 E. 42d St., N. Y. C.

**ACETYLENE GAS**
Prest-O-Lite Co., 30 East 42d St., New York City.

**ACETYLENE GENERATING APPARATUS**
Oxweld Acetylene Co., 30 E. 42d St., New York City.

**ACID, SULPHURIC**
Irvington Smelting & Refining Works, Irvington, N. J.

**AERIAL TRAMWAYS**
American Steel & Wire Co., Chicago and New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.

**AFTERCOOLERS (Air)**
Ingersoll-Rand Co., New York City.

**AIR COMPRESSORS**
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.

**AIR HOSE COUPLINGS**
Knox Mfg. Co., 811-821 Cherry St., Philadelphia, Pa.

**AIR LIFT PUMPING**
Sullivan Machinery Co., Chicago, Ill.

**ANNUNCIATOR WIRES & CABLES**
John A. Roebling's Sons Co., Trenton, New Jersey.

**ANNUNCIATOR WIRES & CABLES, INSULATED**
American Steel & Wire Co., Chicago, Ill., and New York.

**ARMATURE COILS & LEADS**
John A. Roebling's Sons Co., Trenton, New Jersey.

**AUTOMATIC CAR CAGES**
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Roberts & Schaefer Co., Chicago, Ill.

**AUTOMATIC CAR DUMPERS**
Roberts & Schaefer Co., Chicago, Ill.

**AUTOMATIC (Mine Doors, Truck and Electric Switches)**
American Mine Door Co., Canton, Ohio.

**AUTOMATIC SWITCH THROWERS**
American Mine Door Co., Canton, Ohio.

**AUTOMOBILE CABLES**
John A. Roebling's Sons Co., Trenton, New Jersey.

**BALLAST UNLOADER ROPES**
John A. Roebling's Sons Co., Trenton, New Jersey.

**BATTERIES, DRY (for Bells, Buzzers, Signals, Blasting)**
National Carbon Co., Inc., 30 East 42nd St., New York City.

**BATTERIES (Storage, Gas Welding, Cutting, Dissolved Acetylene)**
Prest-O-Lite Co., 30 East 42d St., New York City.

**BELL CORD**
John A. Roebling's Sons Co., Trenton, New Jersey.

**BELTING (Conveyor, Elevator, Transmission)**
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

**BELTING, SILENT CHAIN**
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

**BINS (Coke and Coal)**
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

**BITS Carbon (Diamonds) for Core Drill**
R. S. Patrick, Sellwood Building, Duluth, Minn.

**BITS, Diamond Drilling**
R. S. Patrick, Sellwood Building, Duluth, Minn.

**BIT SHARPENERS**
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.

**BLACK DIAMONDS**
R. S. Patrick, Sellwood Building, Duluth, Minn.

**BLASTING POWDER**
Atlas Powder Co., Wilmington, Del.
E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.
Hercules Powder Co., 934 King St., Wilmington, Del.

**BLASTING SUPPLIES**
Atlas Powder Co., Wilmington, Del.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Hercules Powder Co., 934 King St., Wilmington, Del.

**BLASTING UNITS (Dry Battery)**
National Carbon Co., Inc., 30 East 42nd St., New York City.

**BLOWERS, CENTRIFUGAL**
Ingersoll-Rand Co., 11 Broadway, New York City.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Robinson Ventilating Co., Zelienople, Pa.

**BLOWERS (Tubing)**
Robinson Ventilating Co., Zelienople, Pa.

**BLOWERS (Turbine)**
Robinson Ventilating Co., Zelienople, Pa.

**BLOWPIPES, Brazing, Carbon Burning, Cutting, Lead Burning, Welding, Welding and Cutting**
Oxweld Acetylene Co., 30 E. 42d St., New York City.

**BLUE CENTER STEEL WIRE ROPE**
John A. Roebling's Sons Co., Trenton, New Jersey.

**BOND TERMINALS**
Amer. Mine Door Co., Canton, Ohio.

**BORTZ**
R. S. Patrick, Sellwood Building, Duluth, Minn.

**BREAKER MACHINERY**
American Rheolaveur Corporation, Wilkes-Barre, Pa.
Vulcan Iron Works, Wilkes-Barre, Pa.

**BREAKERS (Construction and Machinery)**
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.

**BREAST MACHINES**
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.

**BRIQUETTING MACHINERY**
Vulcan Iron Works, Wilkes-Barre, Pa.

**BRUSHES (Carbon, Graphite and Metal Graphite for Electric Motors, Generators and Converters)**
National Carbon Co., Inc., Cleveland, Ohio and San Francisco, Calif.

**BUCKETS (Elevator)**
Hendrick Mfg. Co., Carbondale, Pa.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

**CABLE GREASE**
Keystone Lubricating Co., Philadelphia, Pa.

**CABLES**
American Steel & Wire Co., Chicago and New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.

**CABLES (Connectors and Guides)**
American Mine Door Co., Canton, Ohio.
Leschen & Sons Rope Co., A., St. Louis, Mo.

**CABLES, INSULATED**
John A. Roebling's Sons Co., Trenton, New Jersey.

**CABLES, SUSPENSION BRIDGE**
John A. Roebling's Sons Co., Trenton, New Jersey.

**CABLEWAYS**
American Steel & Wire Co., Chicago, Ill., and New York.
S. Flory Mfg. Co., Bangor, Pa.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.

**CAGE DUMPERS, ROTARY**
Roberts & Schaefer Co., Chicago, Ill.

**CAGE (Safety Appliances)**
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.

**CAGE STOPS & LOCKS**
Mining Safety Device Co., Bowerston, Ohio.
Roberts & Schaefer Co., Chicago, Ill.

**CAGERS, AUTOMATIC**
Mining Safety Device Co., Bowerston, Ohio.

**CAGERS, AUTOMATIC & MANUAL**
Roberts & Schaefer Co., Chicago, Ill.

**CAGES**
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Vulcan Iron Works, Wilkes-Barre, Pa.

**CAGES (Self-dumping)**
Roberts & Schaefer Co., Chicago, Ill.

**CALCINERS**
Vulcan Iron Works, Wilkes-Barre, Pa.

**CALCIUM CARBIDE**
Union Carbide Sales Co., 30 East 42nd St., New York City.

**CARBON AND BORTZ**
R. S. Patrick, Sellwood Building, Duluth, Minn.

**CARBON FOR DIAMOND DRILLING**
R. S. Patrick, Sellwood Building, Duluth, Minn.

**CARBON BURNING APPARATUS**
Oxweld Acetylene Co., 30 E. 42d St., New York City.

**CARBON ELECTRODES (for Electric Furnaces and Electrolytic Work)**
National Carbon Co., Inc., Electrode Sales Division, 30 East 42nd St., New York City.

**CARBONS (for Arc Lamps, Blue Printing, Photographic)**
National Carbon Co., Inc., Cleveland, Ohio and San Francisco, Calif.

**CARBON RODS AND PASTE FOR WELDING**
Oxweld Acetylene Co., 30 E. 42d St., New York City.
National Carbon Co., Inc., Cleveland, Ohio and San Francisco, Calif.

**CARBON SPECIALTIES (Circuit Breaker Contacts, Packing Rings, Filter Plates, Tubes, etc.)**
National Carbon Co., Inc., Cleveland, Ohio and San Francisco, Calif.

**CAR DUMPERS, GRAVITY & POWER**
Roberts & Schaefer Co., Chicago, Ill.

**CAR DUMPERS (Rotary)**
Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill

**CAR FEEDERS**
Roberts & Schaefer Co., Chicago, Ill.

**CAR HAULS**
Goodman Mfg. Co., Halstead St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

**CAR PULLERS**
S. Flory Mfg. Co., Bangor, Pa.

**CAR RETARDERS**
Roberts & Schaefer Co., Chicago, Ill.

**CAR STOPS, AUTOMATIC & MANUAL**
Roberts & Schaefer Co., Chicago, Ill.

**CAR WIRE & CABLES**
American Steel & Wire Co., Chicago, Ill., and New York.
John A. Roebling's Sons Co., Trenton, New Jersey.

**CASTINGS**
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

**CASTINGS, GRAY IRON**
Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

**CASTINGS, OPEN HEARTH STEEL**
Vulcan Iron Works, Wilkes-Barre, Pa.

**CHAINS**
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

**CHAINS, AUTOMOBILE ENGINE**
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

**CHAINS, COAL CUTTING**
Goodman Mfg. Co., Halsted St. and 48th Pl., Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.

**CHAINS, DRIVE**
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

**CHAINS, FRONT END**
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

**CHAINS, OILING**
Morse Chain Co., Ithaca, N. Y.

**CHAINS, POWER TRANSMISSION**
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

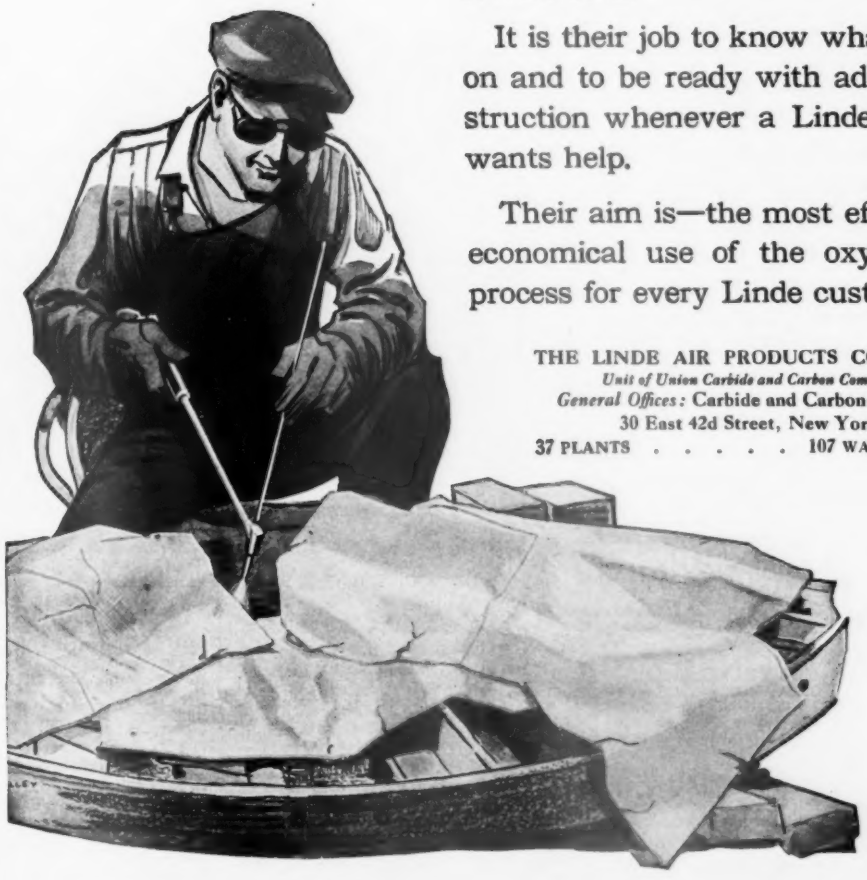
# The WHY of Linde Welding Service

IN A FIELD that is developing and has developed as rapidly as that of oxy-acetylene welding and cutting, it is impossible for even the most alert welder or engineer to keep abreast of new developments.

That is one of the reasons for Linde's service staff.

It is their job to know what is going on and to be ready with advice or instruction whenever a Linde customer wants help.

Their aim is—the most efficient and economical use of the oxy-acetylene process for every Linde customer.



THE LINDE AIR PRODUCTS COMPANY
*Unit of Union Carbide and Carbon Company*
*General Offices:* Carbide and Carbon Building
30 East 42d Street, New York
37 PLANTS . . . . . 107 WAREHOUSES

# LINDE OXYGEN

**CHAINS Silent (Bushed-Pin Joint)**
Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.

**CHAINS, SILENT (Rocker-Joint)**
Morse Chain Co., Ithaca, N. Y.

**CHAINS, SLING**
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

**CHAINS, SPROCKET WHEEL**
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

**CLAMPS, HOSE**
Knox Mfg. Co., Philadelphia, Pa.

**CLAMPS (Trolley)**
Ohio Brass Co., Mansfield, Ohio.

**CLAMPS, WIRE ROPE**
American Steel & Wire Co., Chicago, Ill., and New York.
John A. Roebling's Sons Co., Trenton, New Jersey

**CLIPS, WIRE ROPE**
American Steel & Wire Co., Chicago, Ill., and New York.
John A. Roebling's Sons Co., Trenton, New Jersey

**CLUTCHES**
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

**COAL CLEANING MACHINERY**
American Rheolaveur Corporation, Wilkes-Barre, Pa.
Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

**COAL COMPANIES**
General Coal Company, Land Title Bldg., Philadelphia, Pa.
Lehigh Coal & Navigation Co., Philadelphia, Pa.
Thorne, Neale & Co., Philadelphia, Pa.

**COAL CRUSHERS**
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

**COAL CRUSHERS & ROLLS**
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

**COAL CUTTERS**
Goodman Mfg. Co., Halsted St. and 48th Pl., Chicago, Ill.
Howells Mining Drill Co., Plymouth, Pa.
Ingersoll-Rand Co., 11 Broadway, New York City.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.

**COAL HANDLING MACHINERY**
Conveyor Sales Co., Inc., 299 Broadway, New York City.
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

**COAL LOADERS**
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

**COAL MINING MACHINERY**
Goodman Mfg. Co., Halsted St. and 48th Pl., Chicago, Ill.
Howells Mining Drill Co., Plymouth, Pa.
Ingersoll-Rand Co., 11 Broadway, New York City.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.

**COAL MINING PLANTS**
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.
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Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Wrigley Bldg., Chicago, Ill.

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Ingersoll-Rand Co., 11 Broadway, New York City.

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Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
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### ELEVATORS, BUCKET
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### ELEVATOR MACHINERY
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Ingersoll-Rand Co., 11 Broadway, New York City.

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du Pont Powder Co., The E. I., Wilmington, Del.
Hercules Powder Co., 934 King St., Wilmington, Del.

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Robinson Ventilating Co., Zelienople, Pa.

### FANS, Turbine
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The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Robinson Ventilating Co., Zelienople, Pa.
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### FEEDERS, ORE
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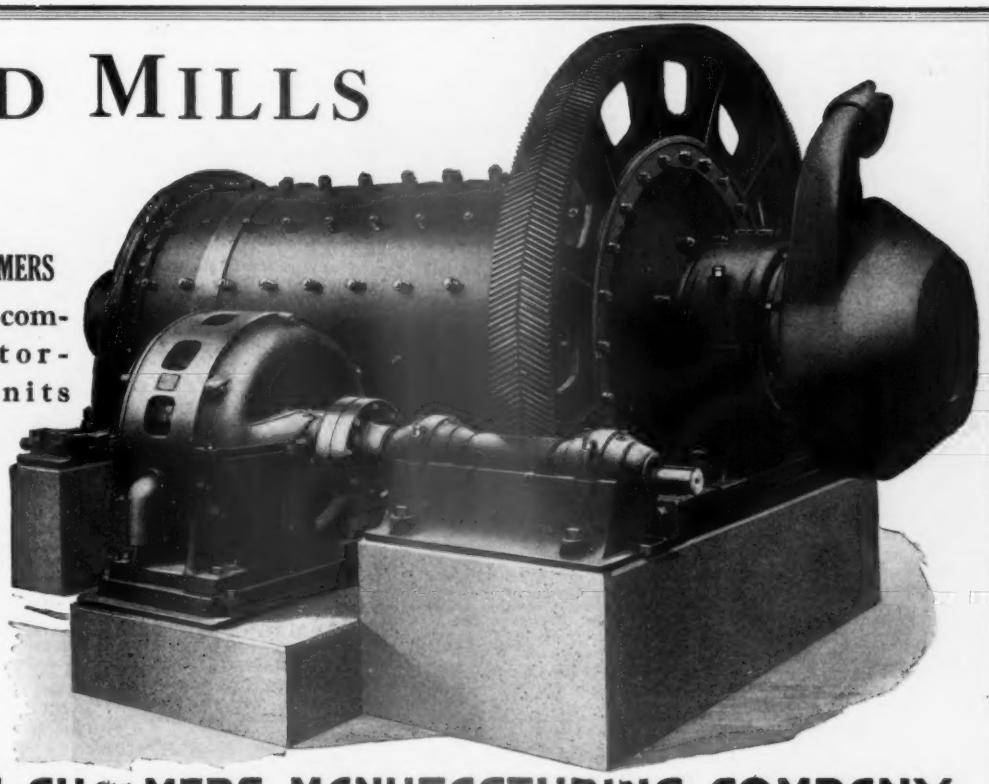

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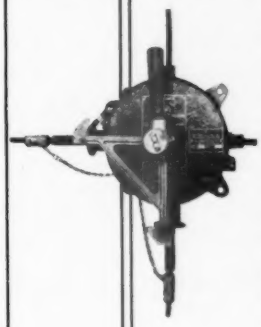

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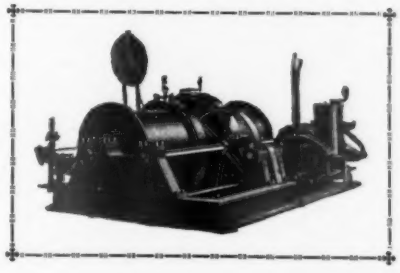

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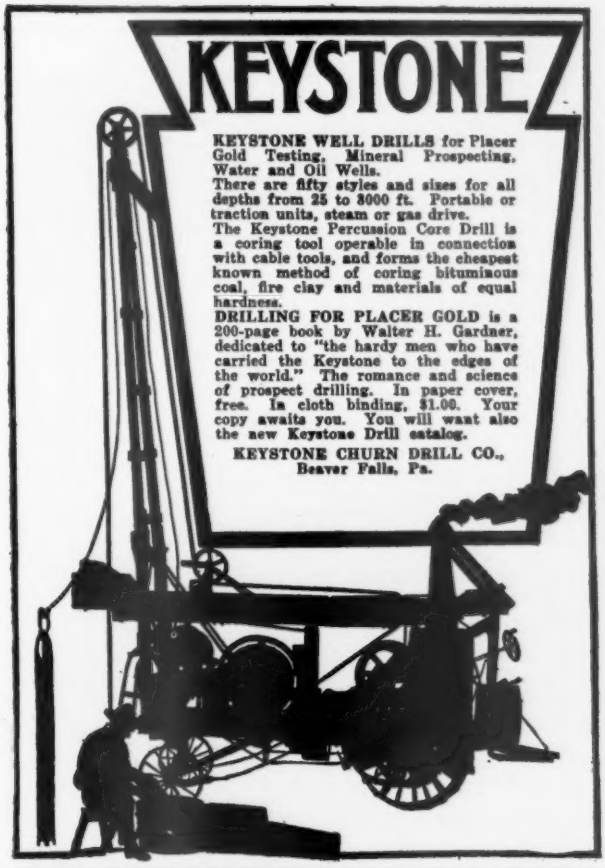

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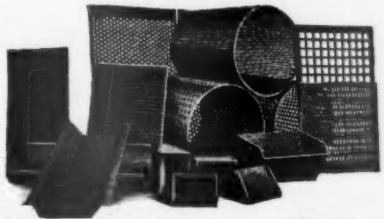

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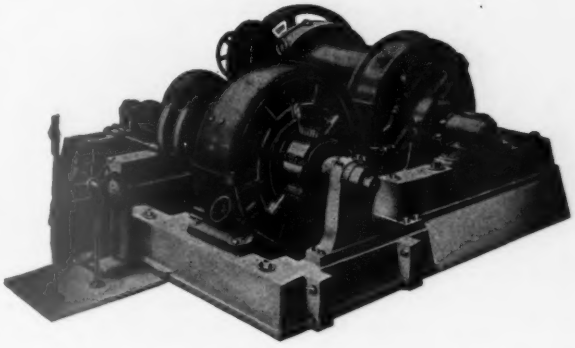

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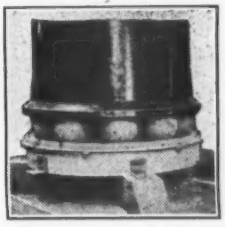

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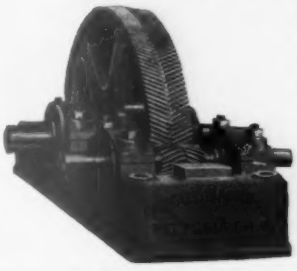

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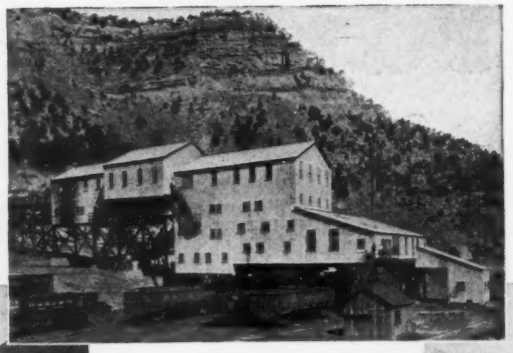

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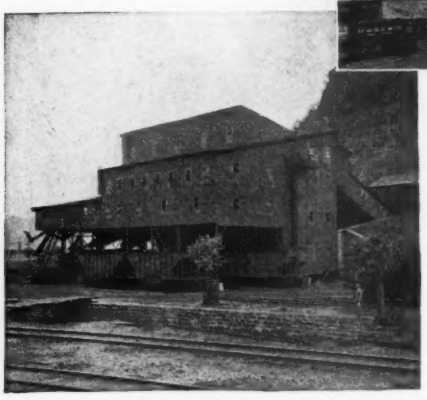

The preparation plant above is that of the Spring Canyon Coal Co., Spring Canyon, Utah. The small sizes are dry cleaned, while the larger sizes are prepared on combination picking tables and loading booms, constructed so as to permit loading either box or gondola cars. Completely designed, equipped and erected by Link-Belt Company.

TO PRODUCE clean and properly sized coal are the main functions of the preparation plant. The method of cleaning may be any one of three systems or combination of one with the other.

1—Manual inspection and picking.
2—Separation of free impurities by dry mechanical methods.
3—Wet Concentration of the washery process.

The type of plant which should be constructed to produce the desired results can only be determined after a thorough investigation of all facts, by engineers experienced not only in theory, but also in practice.

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| Coal Tipples | Screens | Boom Hoists | Vibrating Screens | Conveyors of Every Type |
| Coal Washeries | Retarding Conveyors | Locomotive Cranes | Face Conveyors | Chains, Wheels, Buckets |
| Loading Booms | Car Dumps, Car Hauls | Crawler Cranes | Spiral Separators | Silent Chain Drives |
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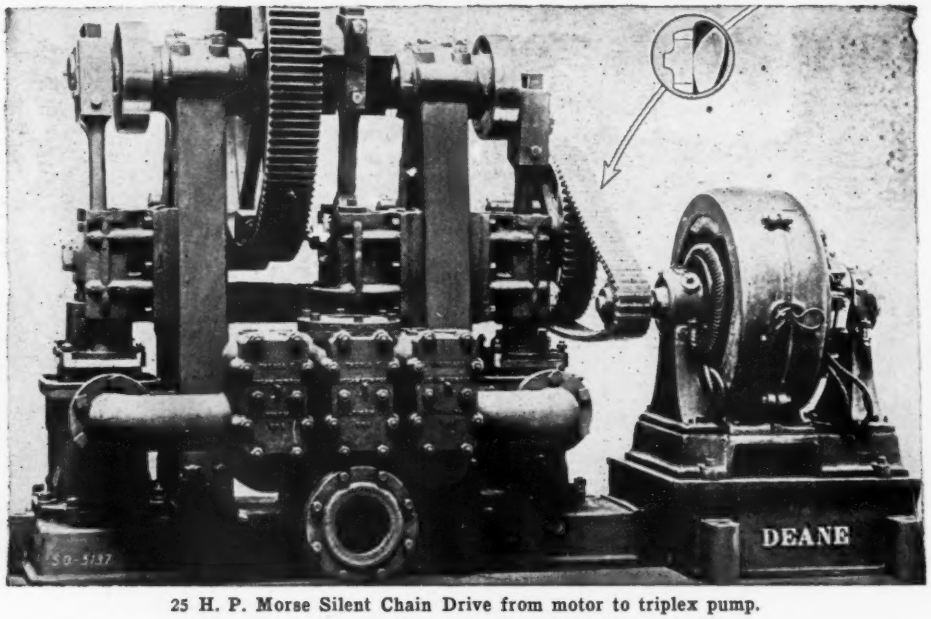


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